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THE TRUE VALUE OF FAURE ACCUMULATORS.

THE capacity and power of the Faure accumulators, or secondary batteries, have been investigated by a commission appointed for the purpose, carrying on their experiments at the Conservatoire des Arts et Métiers in Paris. The cells used in these experiments, thirty-five in number, weighed 43·7 kilos each, or a total weight of 1,530 kilos, about 3,370 lb. The experiments gave the following results, which have been communicated to the Académie des Sciences, and form the only really independent and trustworthy report yet published respecting the apparatus in question. The accumulators were charged by a Siemens machine, and accurate note was taken of the power required for the purpose. The discharge of the cells was made with twelve Maxim incandescent lamps. Between the quantity of electricity sent into the battery and that given off again there was a difference representing a loss of only ten per cent. The return of the cells, considered as electrical *quantity*, is therefore about 89 or 90 per cent. With respect to work done, however, it is shown that the battery only gave out 40 per cent. of the total energy required in charging it, and 60 per cent. of the energy actually stored up by it. This calculation must be taken as referring solely to the disposable electrical energy. If this energy is expended upon a motor machine, to be thereby transformed into mechanical work, the duty obtainable is yet further reduced, and there cannot finally be gathered more than 25 per cent. of the work done in the first instance. The Faure accumulator, completely charged, gives in disposable electrical energy 2,500 kilogrammeters per kilogramme of weight, equal to a weight of cell of 108 kilos per horse power per hour, and 150 kilos per effective horse power expended in mechanical work under the best conditions. It is therefore evident, as the report says, that perfection has not yet been attained in the matter of reducing weight and increasing the storage capacity of the secondary battery. It is, however, a sufficient comment on the wild assertions frequently made respecting the possibility of lighting by incandescent lamps maintained in action by secondary batteries of this character, to find it stated on indisputable authority that the waste of force in the process of charging and discharging these batteries is so serious as the figures now given serve to indicate. Summing up, it has now been demonstrated that the charge of this battery of thirty-five cells required a total mechanical work of 1·558 horse power during 22 h. 45 m., which is equivalent to one horse power during 35 h. 26 m. The battery received only 66 per cent. of the work expended, the rest being absorbed in overcoming passive resistances, and exciting the field magnets. Only 60 per cent. of this power stored up was yielded back by the battery; and it is probable that the same result will be forthcoming in all applications similar to lighting by Maxim lamps.

THE UNION OF HYDROGEN WITH ETHYLENE.

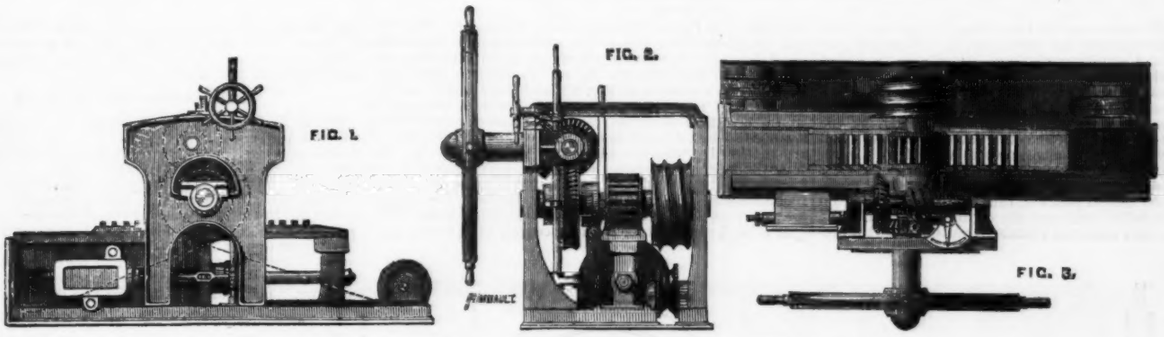
A SUBJECT of interest with reference to the production of hydrocarbon gases in a heated retort has been partially investigated by M. Berthelot, in respect of the union of free hydrogen with ethylene. In a communication to the Académie des Sciences M. Berthelot remarks that he has already shown how free hydrogen unites at a dark red heat with carburets of hydrogen and notably with ethylene; the reaction is, however, limited by the imminent decomposition of the hydrates, by virtue of a true dissociation. The degree of this dissociation varies somewhat rapidly with the temperature of the gas. In M. Berthelot's old experiments, made in a sealed bell at near the temperature of softening glass (550° C.), 51 per cent. of ethylene only was transformed. Working at a slightly lower temperature and for a sufficient time (three hours), M. Berthelot has now succeeded in bringing up the combination to 70 per cent.

STEAM STEERING GEAR AT THE NAVAL AND SUBMARINE EXHIBITION, LONDON.

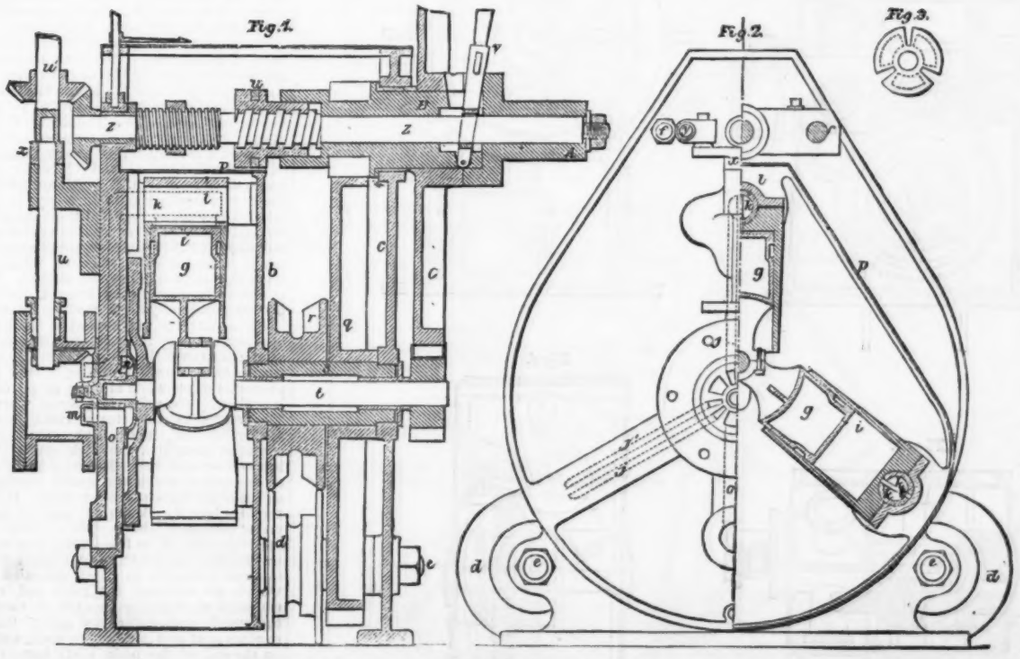
OUR engravings on next page represent Messrs. Amos & Smith's exhibit for combining hand and steam steering gears, in which the change from one to the other is effected without throwing in clutches or toggle pins or otherwise suddenly bringing positive mechanism into gear. Referring to the illustration, it will be seen that a barrel, A, keyed on a shaft is actuated by a crosshead, B, also keyed on the shaft; this latter carries four pinions, C, which gear into two bevel wheels, D and E, one of which is in connection with the hand and the other with the steam power; the movement of either of these actuates the barrel when the other is held by a brake. Another application of the same principle is to two hand gears, each connected with the helm by an independent chain; D is in gear with the steering wheel, and E commanded by a brake. The change required to cause either one or other of the two hand gears to steer is merely to screw down the brake of the one it is desired to steer by. Thus, in the case of a steamer carrying bridge and stearn gears, where the ship has been steered by the bridge gear, and suppose the chain connecting it with the helm has snapped, then it is only necessary to screw down the brake of the stern gear to at once recommence steering without shock or fear of carrying away by any sudden transition, such as often happens in dropping in toggle pins to connect up screw gear. A gain of gearing also accrues, as the barrel has only half the velocity of its motor, D or E, and as the strain is distributed over the teeth of several pinions, a larger barrel can be used, saving the wear usual on the chain when wrapped round a small one.

SIMEY'S STEAM STEERING GEAR.

Another steam steering gear which we illustrate is that of Mr. Charles R. Simey, of 55 Fawcett street, Sunderland.



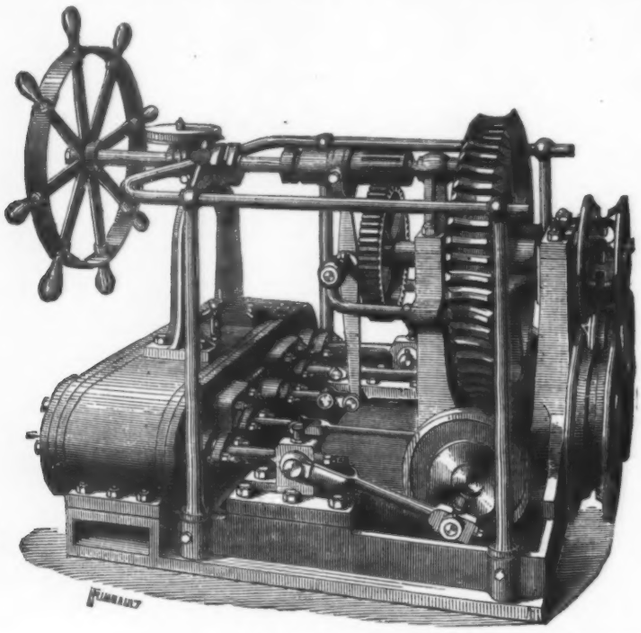
STEAM STEERING GEAR BY MR. SIMEY, SUNDERLAND.

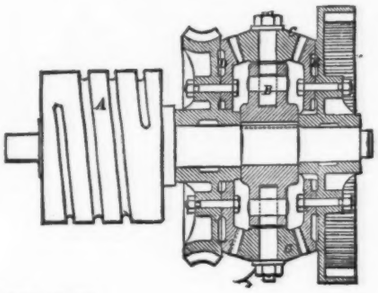


STEAM STEERING GEAR BY MESSRS. HIGGINSON & CO., LIVERPOOL.

STEAM STEERING GEAR AT THE NAVAL AND SUBMARINE EXHIBITION, LONDON.

In this gear but one steam cylinder is used, this cylinder being placed transversely to the vessel, and its piston giving motion to a rack which engages with a pinion on the main shaft carrying the chain barrel. This latter is of large size, so that, if desired, a wire rope can be employed in place of a chain, thus securing silence in working. It will also be noticed that the rope or chain is led off from the under side of the barrel, so as to reduce the "nip" which takes place when the direction of the lead is changed through a large angle in a limited space. The admission of steam to the steam cylinder can be controlled by a small handle (or tiller), or by a small handwheel, as may be preferred by the purchasers, and the movement given to the valve by hand is corrected by the movement of the piston, so that the latter follows the movement of the hand lever, the differential gear being neatly and simply carried out. It will be seen that just at the back of the main framing are two levers connected with a crosshead pushing on a slide rod. One of the levers just mentioned is fixed upon an upright shaft which is moved by hand and opens the slide valve by moving one end of the crosshead, while the other lever is fixed on a hollow spindle which carries a wormwheel worked by a worm on the barrel shaft, the revolution of which causes the lever last mentioned to move so as to bring the center of the crosshead back to its central position, thus shutting off the steam as soon as the rudder arrives at the required position. The design is also such that even a careless helmsman cannot produce an excessive piston speed, while owing to the arrangement of valve employed it is not necessary to empty one end of the cylinder when making short strokes. The gear is also fitted with arrangements for steering by hand, there being on the chain barrel shaft a clutch by which that shaft can be coupled either to the pinion into which the rack gears or to a wormwheel on which the hand gear operates. The arrangement of the hand gear can be readily traced out from our illustrations without further explanation.



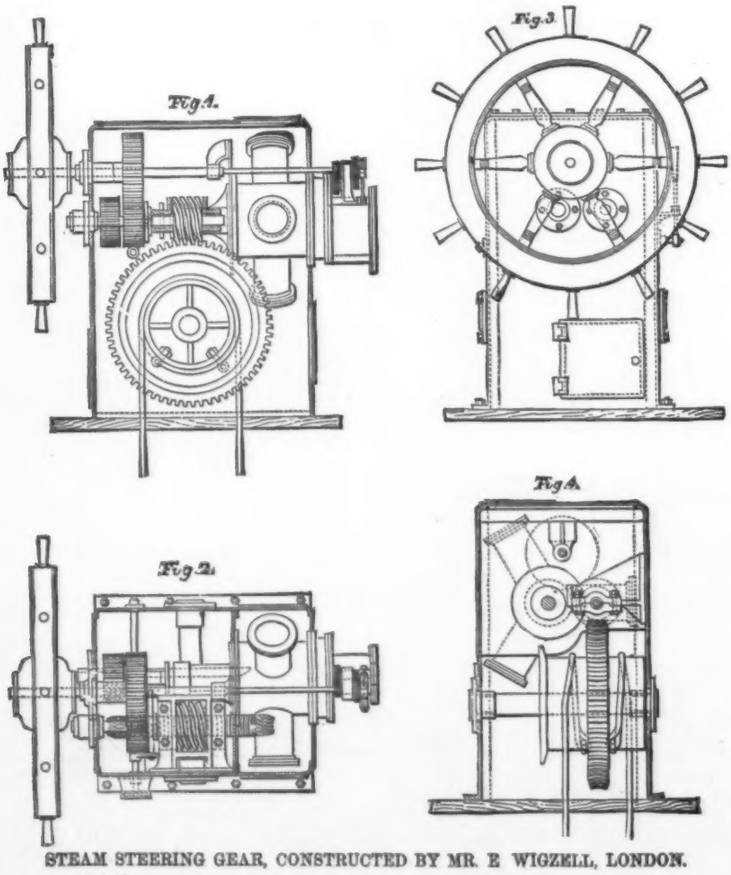


STEAM STEERING GEAR, BY MESSRS. AMOS AND SMITH, HULL.

HIGGINSON & CO.'S STEAM STEERING GEAR.

Another steam steering gear exhibited, which we illustrate, is the "steam quartermaster," constructed by Messrs. Higginson & Co., of Mersey street, Liverpool. This is a gear which has come largely into use, the makers, we understand, having received orders for its application to about one hundred and forty vessels. In our illustrations, Fig. 1 is a longitudinal section, and Fig. 2 a back view, partly in section, of the "steam quartermaster." In these views, *a b c* are three vertical carrying frames, the frames *a* and *c* being arranged to bolt directly to the deck without a sole plate; *d* are the leading wheels working on the screw bolts, *e*. The screw bolts, *e*, act as stays to hold the lower parts of the frames, *a b c*, in position, and also serve as carrying shafts for the leading wheels, *d*, while *f* are stay bolts for holding the upper portions of the frames, *a* and *c*, in position. This gear is worked by a three-cylinder engine, the pistons, *g*, of the engine, being made hollow, and formed each with an aperture, *i*, in their outer ends, in order to allow steam to enter and flow out of the hollow piston when the engine is at work, for the purpose of keeping the piston rod close up against the crank pin at the end of the stroke, or in other words providing for wear. The steam or exhaust passages, $j j^1$, formed in the upright frame, *a*, lead from the passages, $k k^1$, in the trunnion, *l*, past the circular valve, *m*, shown in elevation in Fig. 3, to the annular chamber, *n*; *o* is an exhaust passage leading from the annular chamber, *n*, to any desired position. Light sheet metal covers, *p*, butt between the frames, *a* and *b*, and are secured in position by thumbscrews or hinges, so that they can be readily removed when necessary. It will be noticed that the worm spurwheel, *q*, is secured to the chain wheel, *r*, and is fitted on the sleeve, *s*, surrounding the crank shaft, *t*, carried by the frames, *b* and *c*. The sleeve, *s*, and the trunnions, *l*, act as stays to the frames, *b c* and *a b*.

The direction of motion of the engine is controlled by admitting steam to the passages, *j* or j^1, according to the direction required, the passage not used for steam inlet serving as the exhaust. The distribution of the steam is controlled by the valve, *m* (shown separately in Fig. 3), which is geared by toothed sectors to the shaft, *u*. The upper end of this shaft carries a short arm *x*, the outer end of which is coupled by a rod, *y*, and strap connection to a nut, *w*, on the spindle, *v*. The handwheel is mounted on a bush, A, which, by means of the lever, *v*, can be made to rotate either with the shaft, *z*, or the bush, B, the former arrangement giving a steam and the latter a hand-power steering gear. When steering by steam the handwheel controls the position of the steam-distributing valve through the spindle, *z*, and gear already explained, while the motion of the engine consequent on the admission of steam acting through the wheel, C, bush, B, and nut, *w*, corrects the movement of the valve and brings it back to its central position. The spindle, w^1, is geared to the shaft, *z*, and gives the power of working from the bridge. The whole gear is exceedingly compact and very neatly arranged.



STEAM STEERING GEAR, CONSTRUCTED BY MR. E WIGZELL, LONDON.

WIGZELL'S STEAM STEERING GEAR.

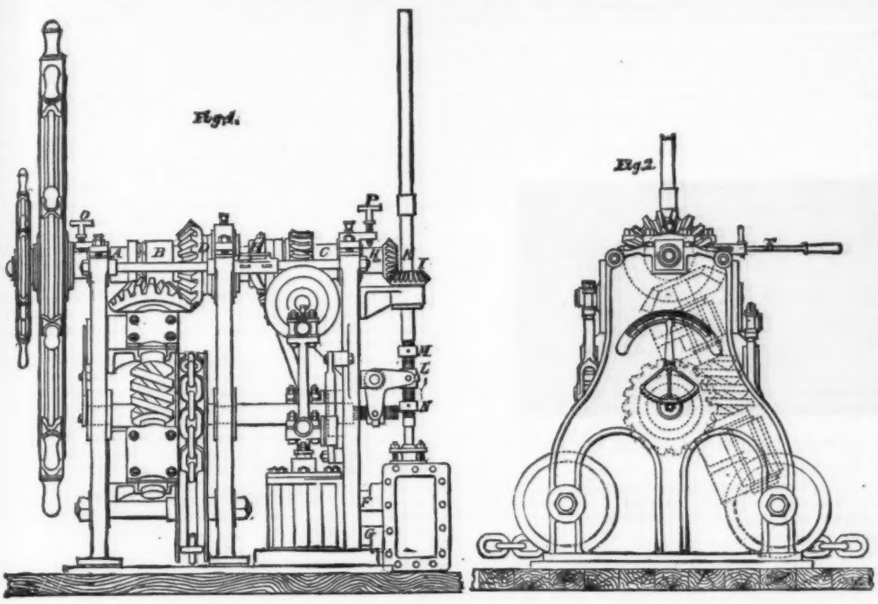
Mr. E E. Wigzell, of 37 Walbrook, is also the exhibitor of a steam steering gear designed by him, and of which we give engravings. Our illustrations will explain the arrangement clearly with but little explanation. It will be seen that the motive power employed is a three-cylinder engine, and the whole of the working parts are incased. The valve is worked by the main steering wheel, the action of which is just the same as if the rudder was being worked by hand. The apparatus is also available for hand steering, there being a lever by means of which the handwheel can be thrown into or out of gear with the spur and worm gear, at pleasure. The chain passes round two drums, as shown.

STEAM STEERING GEAR, BY DONKIN & NICHOL.

This is a combined hand and steam steering gear exhibited by Messrs. Donkin & Nichol, of Newcastle-on-Tyne. The general arrangement of the gear will be readily understood from our engravings, but the controlling valve gear and the provisions for changing from hand to steam power, or *vice versa*, may require some explanation. The apparatus is operated as a steam gear by either the small wheel on the front of the machine, or by the wheel on the captain's bridge, and as a hand gear by the large steering wheel. The clutch, A, is firmly keyed on the handwheel shaft and revolves with it; but the shaft is free to revolve in the sliding sleeve, B, and also scroll wheel, C. The sleeve, B, is fitted with a clutch at each end, one of which engages (as shown) for steam steering, with a corresponding clutch formed on the forward end of the scroll wheel, C, and the other for hand steering engages with the clutch, A. A long feather is firmly fixed in the sleeve, B, which slides in a keyway formed in the vertical miter wheel D, so that if the sleeve is revolved, either by the large handwheel or by the engines, the miter wheel revolves with it, and through the diagonal screw and its scroll wheel turns the main shaft on which the chain sheave is secured, and so operates the rudder. The sleeve is moved in either direction by the lever, E, which is secured in the desired position by a pin passing through it and the sector.

The controlling valve chest at the back of the apparatus is of the ordinary form fitted with a common D valve, and arranged so that the passages, F and G, become alternately steam and exhaust, admitting steam to the cylinders over the steam edges when moving in one direction, and by what is ordinarily the exhaust passage when going in the other. The valves in the steam chest between the cylinders are cylindrical, and each valve is actuated by an eccentric formed on the disk shaft. The handwheel shaft is a hollow steel tube, having a spindle passing through it, on one end of which the small handwheel is secured, and on the other the small miter wheel, H, gearing into the horizontal wheel, J. A similar pair of miter wheels are fitted up on the top of the captain's bridge pillar. The controlling valve rod, K, is fitted with long feathers sliding in keyways formed in the horizontal miter wheels so that it is free to move vertically in either direction. If the small handwheels are revolved the valve rod, carrying the valve, is caused to move either upward or downward, by means of the nut, L, and so uncovers one of the steam ports, and the engines start and continue to work until the screw and nut on the end of the main shaft have moved the bell-crank levers, to which the nuts are attached, to such an extent as to bring the valve back to mid-position, when the steam ports are covered and steam shut off. The screws on the main shaft and valve spindle are so proportioned to each other that when either of the stops, M N, is brought in con-

tact with the nut, L, the rudder is "hard over" to port or starboard as determined by the direction in which the wheels are revolved. The pinching screw, O, is usually screwed into a hole formed in the handwheel shaft to prevent the wheel and shaft revolving when steering by steam, and a similar screw, P, is used to prevent the small internal shaft from revolving when steering by hand. The scroll wheel on the main shaft, the diagonal worm gearing into it, the scroll wheel on handwheel shaft, and the disk shaft, are all solid cast steel. The disk shaft, worm, and eccentric sheaves are formed of one solid piece, the disks only being keyed on.



STEAM STEERING GEAR, BY MESSRS. DONKIN & NICHOL, NEWCASTLE-ON-TYNE.

The handwheel shaft, as already stated, is a thick weldless steel tube. The whole gear is compact and well designed. —*Engineering.*

CONWAY VIADUCT, NEW HAVEN AND NORTHAMPTON RAILWAY.

OF the above viaduct, built by the Keystone Bridge Co., of Pittsburg, Pa., the following notes will give some description:

It was built and erected in the winter of 1880-81. There are 12 plate girder spans of 30 ft. each; 3 plate girder spans of 40 ft. each, and 1 trussed girder span of 70 ft. The highest trestle is 115 ft. from base of rail to masonry.

The girders are provided with iron floor-beams and stringers, and are placed 10 ft. between centers. The parts were proportioned in accordance with the standard specifications of the Keystone Bridge Co. for heavy traffic and standard gauge. The additions made to the rolling load to allow for impact are 25 per cent. for floorbeams and stringers, 20 per cent. for the 30 ft. girders, and 15 per cent. for the 40 ft. girders. The wind surface of a passenger train was assumed equivalent to a continuous surface 3 ft. above the rail, 10 ft. high, and of a freight train, ditto, 8 ft. high. The maximum stresses in columns occur when a freight train pulled by the specification engines is on the tracks with the wind blowing at 30 lb. per ft. and brakes applied. The latter condition was assumed to produce a sliding of the wheels on the rails, for which the coefficient of friction was taken at 2-10. For these extreme conditions an addition of 50 per cent. was allowed to the unit strains prescribed for ordinary loading. The batter of columns is 2 in. per ft. vertical, giving a base of about 47 ft. for the trestle, 115 ft. high. This batter is sufficient to reduce the tension in the windward columns under the above extreme conditions to a very small amount. The columns are anchored to the masonry with provisions for temperature expansion.

On plan the center line of the structure forms an acute angle with the axis of the ravine, and if, as is usually done, the pedestals were built so that each two pedestals opposite each other would have the same elevation on top, very heavy masonry towers would have been requisite. To avoid this the two columns in one trestle are made of different length to suit the contour of the ground, and the difference in length is as much as 25 ft. in one case.

The viaduct was erected by means of a traveler without false works. This method of erection for spans as large as 60 ft. requires a traveler 120 ft. long; it was successfully pursued by the Keystone Company, on a large number of viaducts on the Cincinnati Southern Railway and other roads, and it was the first to adopt it for spans of such length.

PROGRESS OF THE WORK ON THE HUDSON RIVER TUNNEL.

WE lately visited the New York terminus of the tunnel to note the progress which had been made.

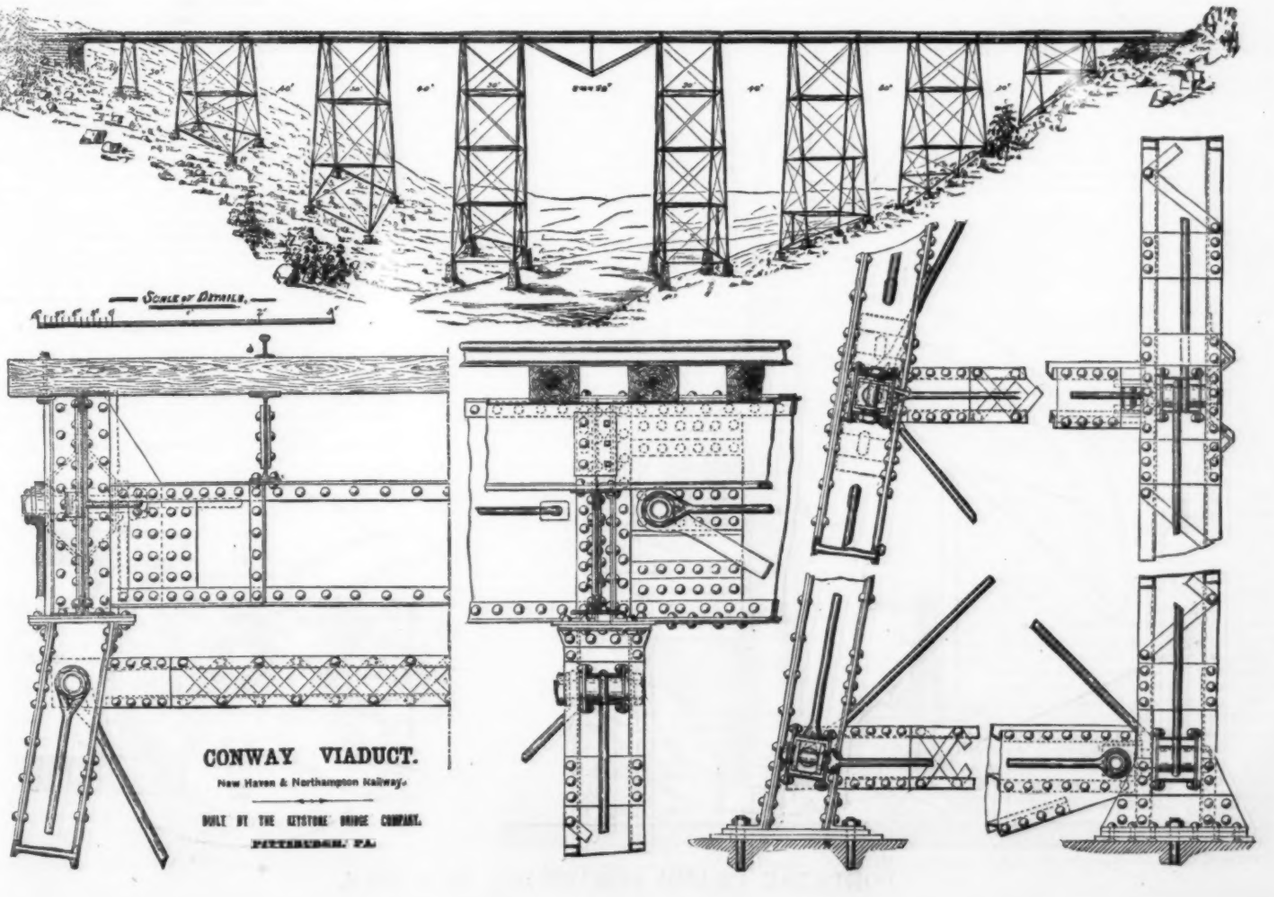
Upon entering the boarded inclosure at the foot of Morton street the first objects the eye rested upon were two large piles of brick, and the conclusion was quickly formed that the work on this side was progressing most favorably and rapidly. A closer inspection revealed the fact that these piles were only used as weights to keep the caisson down. Between them was a shaft leading down to the supply lock on top of the caisson, the material being raised and lowered by a small steam engine located near the river side of the shaft. Descending two short flight of steps, the "passenger" air-lock was reached at the top of an iron shaft extending to the interior, means of locomotion being provided in the shape of ladders fastened to the sides. This lock is similar to the one used for some time on the other side, and with which our readers are familiar.

The inverts for the two tunnels are finished and the sides and dividing wall completed for about two feet above the interior of the bottom. In the center of the dividing wall, and at equal distances apart, are three iron pipes 1 ft. in diameter, and extending vertically from the interior of the caisson 6 ft. below the bottom of the invert. These pipes are about one-half full of broken stone, and terminate in oblong perforated boxes reaching to the masonry, and also filled with stone. The cement is mixed one to one and one to two, according to quality, while pure cement alone is used around the pipes. This caisson is sunk in a bed of sand, which extends toward the other shore for 200 or 250 ft.

The problem which now perplexes those in charge is how to cut through the side and start the tunnel proper. The first experiment to be tried will be to connect the vertical pipes with powerful pumping machinery and ascertain if the water can be drawn from the side through which it is designed to cut. The opening in the caisson on the other side of the river, opposite the South Tunnel, was only made after sufficient silt had been rammed through a small hole to render the outside silt of the required consistency to hold the air. But this caisson being sunk in sand, the whole aspect of affairs is changed. Moreover, it has been found that the sand will follow the water into the caisson upon the diminution of the air pressure, which on Tuesday was 26 pounds per square inch.

THE JERSEY HEADING.

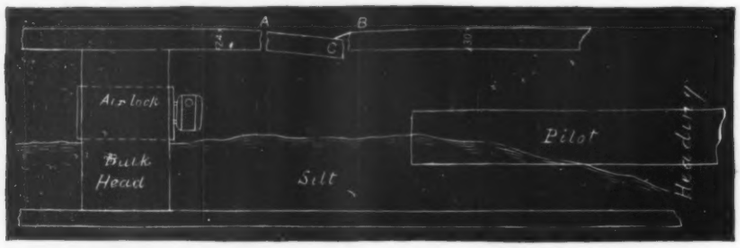
On the following day we visited the work at the New Jersey end, and noted several changes that had been made since the visit by the members of the American Society of Civil Engineers. Work upon the South Tunnel has been stopped for the present on account of a lack of facilities for handling the material. An elevator has been placed in the shaft, and as the cars are brought up the tunnel they are run upon the platform, raised to the surface, and run upon a track leading to low lands back of the works. Walking down the North Tunnel, we soon came to the bulkhead containing two air-locks, one of which was designed to be always opened toward the heading, thus affording a sure retreat for the men in case of accident. Entering this, we were soon under a pressure of about 25 lb. to the square inch, when we emerged into the second stretch of completed



work. About 300 ft. from this bulkhead is a second, which is furnished with but *one* air-lock. Entering this, we were subjected to a still further increase of pressure, and came out about 40 ft. from the heading. According to the mercury gauge, which we consulted after coming to the surface, the pressure in this section of the work was betwen 32 and 33 lb. to the square inch.

All the material is lowered by the elevator, run down to the first set of air-locks, passed through, drawn by a horse (we may state of this animal that he stands the pressure well, eats heartily, and is gaining in flesh, and that he has almost recovered from the heaves from which he suffered when first admitted) to the second lock through which it passes to the men. The entire tunnel has been kept a little over half full of excavated silt, which will be removed after the approach shall have been completed.

About 10 ft. from the interior end of the second bulkhead a break is perceived in the roof, and the 10 ft. beyond this slope rapidly downward until the far end is about 18 in. from the grade line. The 10 ft. section adjoining this is commenced on grade and so continued. The accompanying



HUDSON RIVER TUNNEL—LONGITUDINAL SECTION THROUGH SECOND AIR LOCK.

sketch will aid in understanding the work. The top of the tunnel had been finished to A on grade, but when the iron plates were put in place for the next section a settlement took place which resulted in a deflection at B of about 18 in., and left an uneven opening at A sufficiently large in some places to thrust in the hand. The next section, commencing at B, was started on grade and so finished. The opening at B, between the ends of the masonry, is large enough for a man to crawl into. In order to keep the silt back short boards and plates have been inserted from B to C. The section beginning at B has been finished, and work is now in progress on the next one. We were informed that the grade of the lower portion of the tunnel had been kept true. To strengthen the tunnel the arch is now being made 2½ ft. thick, the increase being made as shown in the drawing.

After completing the section now being built, that portion between A and B will be removed and rebuilt on the proper grade. This settling seems to have resulted from the failure of the surrounding silt to hold the air, and the two following sections were begun in order that it might have time to attain the requisite consistency. The work at the heading is carried on in the manner so frequently described.

All the work completed since the accident of 1880, from about 300 ft. from the shaft to the second air-lock, presents the appearance of excellent workmanship. The grade has been kept with the exception of that section above described, and the interior surface is straight and regular.

The tunnel is lighted by electricity furnished by two dynamo machines located in the engine-room, the lights being so distributed as to illumine the work from the shaft to the heading.

In an undertaking of this description much depends upon the class of workmen employed, and the class in turn depends upon the wages paid. The masons get from $3.50 to $4, and the laborers and helpers from $1.50 to $2.25. At present each shift works eight hours, with a one-half hour rest outside.

Almost every man has had an attack of the "bends," although no very serious cases have as yet occurred. Strict rules have been found necessary for the good of the men. Every new man is examined for heart or lung trouble by the surgeon of the company. It is compulsory for the men when entering to use the elevator in preference to the stairs leading to the bottom of the shaft. Hot coffee is sent into the tunnel just before the time for coming out. All violent exercise is discouraged, the use of spirituous liquors prohibited, and regular habits recommended.—*Engineering News.*

NEW CASK CRANE.

MESSRS. POIROT and CHERTEMPS, of Paris, have invented and are now constructing a species of crane for hoisting purposes, but more specially designed for the handling of casks. This sort of apparatus bears the name of *machine à gerber*, that is, "cask-piling machine."

An apparatus of this kind, to be effectual, should be of limited size and weight—two conditions that, in the type under consideration, are perfectly fulfilled.

The machine consists of a truck base provided with four wheels, two of which form part of a fore-carriage. From the middle of this base rises a small conical column, around which revolves the crane jib and its mechanism. This jib bends over to seize the casks and then elevates them. A toothed sector, gearing with an endless screw which is acted upon by a winch, effects the lowering or raising of the jib. When the jib is lowered the machine may be passed through the lowest doors.

A counterpoise affixed to the toothed sector balances the jib and partially the load, so that the stress is diminished to as great a degree as possible.

The simplicity of this mechanism (the chain and ratchet being suppressed) preserves the operator at all times from danger of accidents; since, as soon as he lets go of the winch, the load remains suspended.

DESCRIPTION OF FIGURES 1 AND 2.—The crane consists of three parts: 1, The truck; 2, the movable column supporting the jib; and 3, the jib mounted on its sector. Fig. 1—Vertical sectional view through the line 5 6 of the plan. Fig. 2—Horizontal sectional view through the line 1, 2, 3, and 4 of the elevation.

A, the cast iron truck base. *a*, the conical column, carrying a steel step-bearing, *a'*. *b*, the fore-carriage and its wheels. *c c*, swan's-neck supporting the fore-carriage and cast in a piece with the truck. *d*, screw, nut, and winch, mounted on the swan's neck and serving to raise and lower the truck on the fore-carriage so as to lift the feet, *b'*, during the shifting of the crane. These feet, *b'*, give stability to the apparatus while it is in operation. *e*, cross-bar for turning the fore-carriage, and serving as an axle to its wheels. *f*, lever for guiding the fore-carriage, and serving also as a pole for drawing the machine from one place to another. It is held in a sheath, cast in a piece with the swan's neck, by means of a key. *g*, a square, movable bar provided with leveling screws, and capable of being shoved to the left or right of the truck (under which it slides), in order to increase the range of the crane over the ground.

The fellies of the hind wheels are provided with apertures for the reception of a lever which serves for moving the crane backward and forward to short distances during the progress of the work.

B, a movable cone-shaped column supporting the jib, C, and pivoting on the inner cylinder, *a*, by means of the step-bearing, *a'*. *h*, an endless screw of large diameter, having a single thread, placed in a covered box mounted on the axis of the screw, and actuating the sector for raising and lowering the jib. *i*, a helicoidal wheel mounted on the axis of the endless screw. *j*, the pinion that controls the wheel *i*, and which is mounted on the axle of the controlling winch, *k*, that serves for the lifting of heavy loads and the maneuver of small weights. *l*, wheel for regulating the velocity of the helicoidal pinion. *r r*, movable counterpoises which revolve with the column in constant opposition to the load.

C, the iron jib.

D, the toothed sector, which gears with the endless screw, *h*, and forms one piece with the jib. The enlarged base, *n*, of this sector forms a counterpoise to the weight of the iron of the jib.

E, the joint connecting the jib and sector, and about which both revolve.

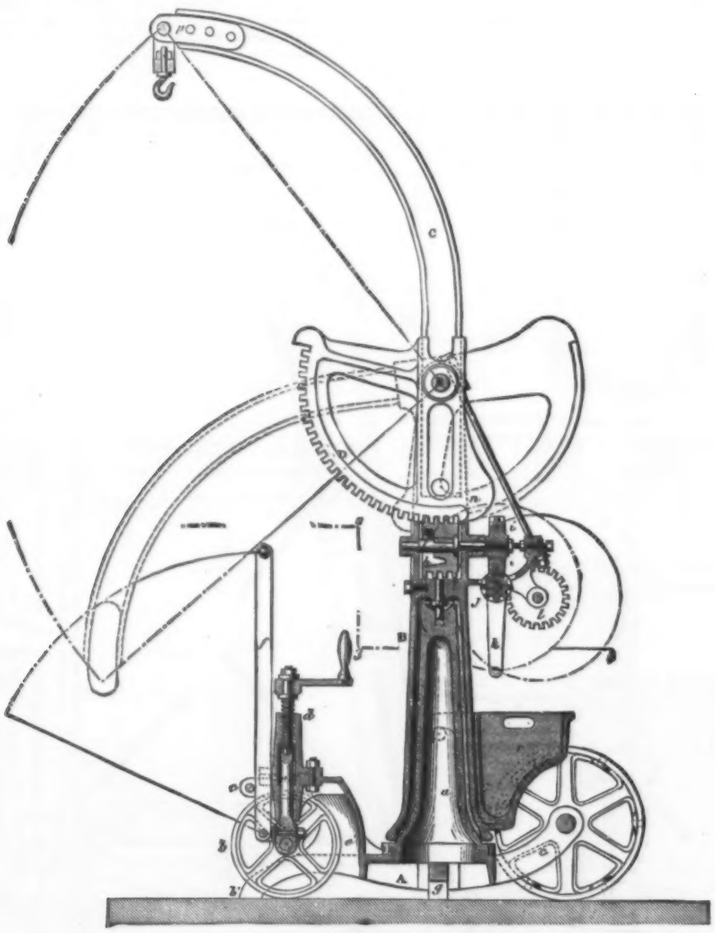
CABLE ROADS A NEW SOURCE OF POWER.

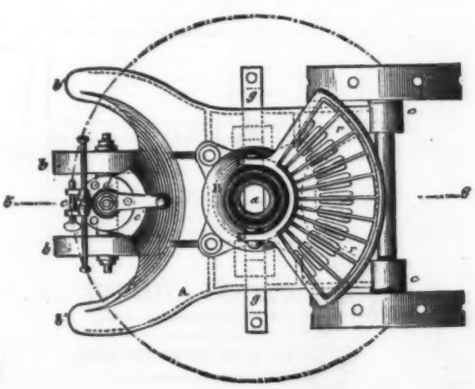
FOR over a year the Wallman Bros. have been running the machinery in their shop, No. 1128 Sutter Street, by a power taken from the cable of the Sutter Street R. The connection is made by means of a boxed underground shaft, running from under the floor of their workshop to the center of the street. At each extremity of this shaft is a single wheel, about four feet in diameter. The one in the street is of iron, with a groove, in which the cable runs. A wooden wheel answers all purposes at the other end, and on this are belts connecting with the machinery. The usual rate is equal to one-horse power, but it may be increased or diminished by means of a depression pulley, which bears the cable down upon the larger wheel. Two machines are at present run by this power, and it is described as most satisfactory, being smooth and reliable.

The wearing power of the cable is something enormous, and the heavy iron pulley bearing on it is worn through in a short time. The bearings in the street require oiling twice a day. This is about the only location on the street where, it is represented, connections in this manner could be satisfactorily made, as the engineers are required to raise their gripe from the cable at a certain distance from the Larkin street cable, and in that way the apparatus never interferes with the driving-wheel and bearing-pulley. A few months ago, however, an inexperienced engineer omitted this precaution, and several valuable castings were broken by the gripe in an instant. Many locations may be found on the other roads where this power might be utilized, the railroad companies demanding only a nominal rent. This power is less expensive than the stationary engine, and in many respects seems quite as satisfactory. Means may yet be devised for utilizing the power created by these railroad cables in driving sewing-machines, coffee-mills, and a variety of other light-running stationary machines in residences and stores on the lines of these cable roads.—*San Francisco Bulletin.*

THE CHICAGO WIRE CABLE SYSTEM.

THE cable system of street-car propulsion introduced on the Chicago City Railway some weeks ago is operating very successfully, and street railway officials of other cities, notably Philadelphia and Boston, have about decided to adopt a similar plan. For the following short note on this system,

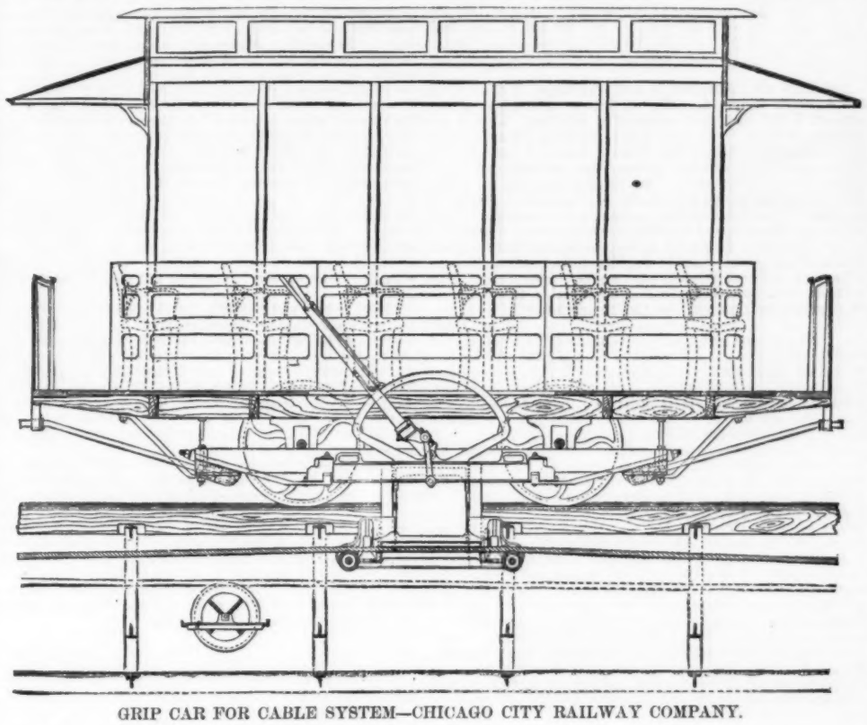




PORTABLE CRANE FOR PILING UP CASKS.

together with the accompanying engravings, we are indebted to the *American Engineer* of Chicago, from whose office, we understand, a pamphlet will shortly be issued fully illustrating and describing this system and its possibilities for other cities:

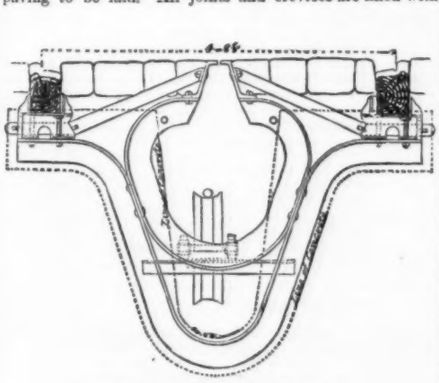
We give below a sectional elevation of the grip car now being used on the State street line of the Chicago City Railway Company, in connection with the wire cable system. The position of the cable, in and out of the grip, will be seen, as well as the carrying pulleys. The action of the grip on the cable by the movement of the lever can be readily understood upon inspection of the grip itself. The car is built to carry passengers with the seats arranged after the fashion of ordinary railway cars, the aisle, however, being reserved for the grip and brake levers and the operator. The main feature of the track is the yoke holding the whole track together. This is made of wrought T iron, in two pieces, riveted together by the webs as shown.



GRIP CAR FOR CABLE SYSTEM—CHICAGO CITY RAILWAY COMPANY.

Two cast iron chairs are used, one bolted to each end of the yoke; these chairs hold the wooden stringers, which are laid therein and tightly secured in place. A wrought iron bar is bolted to each side of the center groove rail, passing through the cast iron chairs to which they are wedged, the object being to keep the groove or slot of the proper width. In constructing the track the ditch is excavated to the full width of the yoke. The yokes are placed four feet apart and the center groove rail bolted to them. The chairs and stringers are then fixed in place, the rails put on, and the track lined up.

This being complete, wooden walls are placed in position and concrete deposited in the form shown by the dotted lines on cut. The intervening space between the top edges of the concrete and the groove rail is covered by sheet iron, which thus completely closes the tunnel, and enables the paving to be laid. All joints and crevices are filled with



CROSS-SECTION OF TRACK.

cement, and the interior face of the tunnel is made perfectly smooth. The cable is held in its proper position by small wheels, which are sustained and connected in the manner shown in cut.—*Railway Review.*

A full account of the San Francisco cable railways will be found in the SCIENTIFIC AMERICAN SUPPLEMENT, No. 298, with several engravings.

THE *Journal of Gas Lighting*, in the review of the past year, says: "Perhaps the most positive and abiding result of the rage for electric lighting in public streets is the increase of gas consumption which inevitably follows the removal of the electric lamps, or is insisted upon in districts adjacent to those occupied by the electricians. The old style of street lighting, with five foot burners, or even worse, will no longer satisfy the public in busy thoroughfares. More light is demanded even from gas, and there is consequently a large and growing use for high-power gas burners."

THE PRODUCTION AND USE OF GAS FOR THE PURPOSES OF HEATING AND MOTIVE POWER.*

By J. EMERSON DOWSON.

ALL here this evening are accustomed to the use of coal gas for lighting purposes, and by many it is looked upon as almost a necessity. It is, in fact, hard to realize that so extensive a use of it has been developed during little more than half a century. Fifty years ago, nearly all towns were lighted, or said to be lighted, with miserable oil lamps, and now the capital publicly invested in works for the supply of gas in the United Kingdom amounts to something like forty-five millions; and, for London alone, it is over thirteen millions sterling.

The manufacture of lighting gas, on so large a scale, has naturally led to the improvement and cheapening of its production; and this, again, has led to its more extended use for lighting, and to its adoption to a certain extent for heating and motive power. This more general use has led us to become familiar with the advantages of gas as a fuel; but we have also learned the unpleasant fact that its use for such a purpose is generally attended with much more expense than when coal or coke fires are used. We now know that gas engines are theoretically more efficient than hot-air or steam-engines, and we know that they cannot burst like steam-boilers; but their general adoption is greatly impeded by the high price of the fuel they require.

Ordinary coal gas is also admirably adapted for cooking and innumerable heating purposes, but in the hands of careless persons (and they outnumber the careful ones) it is certainly not economical, compared with coal or coke. Supposing, however, that gas were at such a price that it could be extensively used for fuel, its consumption would be enormous, and as it would greatly reduce the quantity of raw coal used in open grates, the smoke nuisance from which we suffer so seriously in large towns, would, without doubt, be sensibly abated. We see, therefore, that much may be gained by our having suitable gas at low cost for heating and motive power, but we have not yet determined how this is to be accomplished. It is, however, a question bearing directly on our health and comfort, and on fuel economy; and as such, it is one of national importance, and therefore deserving of our best attention.

What we really have to do is to consider separately the question of gas for lighting, and of gas for heating; and until this is done, and until we appreciate the principles involved in each case, I fear we shall not arrive at sound and practical conclusions. First, therefore, it will be well for us to remember that, after all, our so-called lighting gas has a very small percentage of illuminating constituents. Rich Manchester gas has only about 6½ per cent., and ordinary London gas so little as 4 per cent. Roughly speaking, average London gas consists of hydrogen, 52 per cent.; marsh gas, 35 per cent.; carbonic oxide, 8 to 9 per cent.; and olefiant gas, 4 per cent., so that in every 100 cubic feet we have about 96 cubic feet of non-luminous heat-giving gases, and only 4 cubic feet of luminous gas. The addition, however, of this small proportion of illuminants adds very greatly to the trouble and cost of preparing the gas, and although this addition is essential for lighting, it is not in the least necessary or desirable for heating purposes.

In the phenomena attending the combustion of lighting gas, the non-luminous heating gases serve to raise the temperature of the carbon particles to a white heat, and it is the incandescent carbon which produces the lighting effect. It is, therefore, consistent with the teaching of science that there should be a large preponderance of heat-giving gas present with the lighting gas, although we have certainly not obtained the best possible proportions in our London gas. We have now to consider what occurs when we use lighting gas for heating purposes, and we shall see that other conditions then obtain. As a matter of fact, when such gas is used as a heating agent, the first thing we almost invariably do is to destroy its luminosity, by the Bunsen, or other atmospheric burners, or blow pipes, used.

Here I have a jet of ordinary lighting gas, and if I wish to heat a vessel with it, I cannot let the gas touch the vessel without a deposition of soot, owing to its cooling effect on the flame, and this involves a loss of heat, the soiling of the vessel, and a waste of gas. If I place the gas jet so far under the vessel that the tip of the flame is not in contact with it, I lose much heat, radiated from the sides of the flame, and in cases where a concentrated heat is required, there would also be difficulty in burning the needful quantity of gas. To meet these difficulties, we use a burner, or a blow-pipe, which causes a certain quantity of air to mix with the gas before it is ignited. But as you see, the immediate effect of this is to destroy the luminosity of the flame, for the carbon is brought into such close proximity to the oxygen of the air, and their chemical combustion takes place so rapidly, that apparently there is no intermediate stage of incandescence.

It is true that olefiant gas has a high calorific power, but it is less than that of hydrogen or marsh gas, and it can be well replaced by either of the latter, where heat only is required. We see, therefore, that the presence of the costly illuminating constituents in ordinary coal gas is not only unnecessary for heating purposes, but adds considerably to the difficulty of using it. It then naturally occurs to one to ask, are we right in adhering to the ordinary method of producing gas when required for heating purposes, and cannot other suitable gas be obtained at less cost than ordinary lighting gas? It is my belief that both these questions can be answered in the affirmative, and I will give you my reasons.

In the first place, it has long been established, and is well known, that highly heating non-luminous gases can be produced by decomposing steam in the presence of incandescent carbon, and it only remains to prove that the process can be carried out in a simple way at a moderate cost. Dr. Siemens was the first to prove to the world on a practical scale, in connection with the regenerative furnaces, the great economical and other advantages of using cheap gaseous fuel. This is now matter of history, and his system, or some close imitation of it, has been adopted in all manufacturing countries. In the Siemens gas producer, air only, or air mixed with a small quantity of steam, passes through a mass of red-hot fuel, and gas so made answers extremely well when used in large quantities, and when highly heated in the regenerative chambers of a furnace. It however contains 60 to 70 per cent. of nitrogen, and this large proportion of incombustible gas renders it unsuitable for use in small quantities, as for instance, in ordinary gas burners, or in gas engines, etc.

Many other systems have been tried, but it would serve no useful purpose here to describe all that has been done in this direction. Suffice it to say, that the early attempts chiefly consisted of passing steam through iron retorts, charged with carbonaceous fuel, rendered incandescent by external fires. The steam was decomposed, and some of the oxygen combined with the carbon of the fuel, but some of the oxygen also combined with the iron of the retorts, and the process was necessarily abandoned. Messrs. Kirkham introduced the method of decomposing steam by passing it through a column of fuel previously rendered incandescent by an air blast. In this way external fires were dispensed with, and as the retorts could then be lined with refractory material, their oxidation was prevented, and the working cost was considerably reduced. Air was first forced into the generator, until the temperature of the fuel was very high. The air-inlet was then closed, and steam was let in. The latter was at first readily decomposed, but at the expense of much heat withdrawn from the fuel; and soon it was necessary to turn off the steam and again introduce the air blast. To make up for the want of continuousness in the process, two generators were worked alternately, and this, and the constant variation in the temperature of the fire, caused serious fluctuations in the quality of the gas.

Many modifications of Messrs. Kirkham's apparatus have since been introduced, but nearly all depend on the intermittent passing of air and steam through the fire. We have already seen that Dr. Siemens has, in some cases, adopted the plan of passing a mixture of steam and air through a fire, and although his gas is weak, it has the advantage of being continuously produced, and of being uniform in quality.

In 1875, Mr. J. Kidd patented an apparatus by which he made somewhat similar gas, and a paper on it was read before this society, in April, 1878. The chief novelty in this apparatus was the placing of a coil round the sides of the gas generator, so that water introduced into the coil might be converted into steam by the heat of the generator fire, the steam thus produced being afterward passed through the fire and there decomposed. This answered well when the fire was carefully attended to, but if it was neglected for a short time, the wet steam and water passed from the coil, and the apparatus soon became unmanageable. Careful experiments with this gas showed that its calorific power was only 20 per cent. that of ordinary London gas, while the temperature of combustion was also much less than that of the latter.

With your permission, I will now describe briefly the apparatus, of which there is a model before you. This model is half the actual size of a generator which produces 1,000 cubic feet an hour. In this system I have imitated Dr. Siemens and Mr. Kidd, in passing a mixture of steam and air through a fire, but I have adopted special means for producing and superheating the steam, and for maintaining all the conditions of working constant and simple, and by so doing I have sensibly improved the quality of the gas produced. A full-size vertical section of the whole apparatus is shown on the diagram, and from this it will be seen that the steam producer and superheater consists of a long length of tubing bent in such a way as to bring nearly the whole of it over some gas flames underneath. Water, at a pressure of 20 to 25 lb. per square inch from a town supply, from an overhead cistern, or from a pump with accumulator, is passed into the coil, and there converted into superheated steam. When the cock regulating the inlet of water has been adjusted, and when the gas has been lighted under the coil, the conditions as to temperature and pressure are constant, and this part of the process needs no further attention. The gas required for heating the coil is drawn from the gas-holder, but on the first occasion of starting the apparatus, or whenever there is no gas in the holder, a fire is lighted on a grate under the coil. The retort, or generator, has an iron casing, to make it gas-tight, and this is lined with ganister, as in a foundry cupola, to prevent loss of heat and oxidation of the metal. The fire rests on a grate, and under the latter is a closed chamber, into which a jet of the superheated steam plays, acting as an injector, and carrying with it, by induction, a continuous current of air. The pressure of the steam forces the mixture of steam and air upward, through the fire, so that a high temperature of the fuel is maintained, while a continuous current of steam is simultaneously decomposed. In this way the working of the generator is very regular, and the gas is produced rapid-

* A recent lecture before the Society of Arts, London.

ly, and without fluctuations in quality. The well known reactions occur: the steam is decomposed, and the oxygen from the steam and air combines with the carbon of the fuel to form carbonic acid, which is reduced to the monoxide on ascending the fuel column. Approximately the composition of this gas by volume is: hydrogen 20 per cent., carbonic oxide 30 per cent., carbonic acid 3 per cent., and nitrogen 47 per cent.

Where uniformity of pressure is required, as for engines, burners, etc., or where storage is needed, the gas is passed into a holder. This somewhat retards the production, but the injector causes gas to be made so rapidly that a holder is easily filled when weighted to give a pressure of one to two inches of water, and at this pressure a generator can pass gas continuously into the holder, while at the same time it is being drawn off for consumption. For boiler and furnace work, the gas can be used direct from the generator, and in such cases, where there is no gas-holder, I do not use the superheater above described, but I produce the steam in the gas generator itself. Instead of solid bars for the grate, I use hollow ones, and these I connect together in such a way that the water or steam passes through each bar successively. The heating of these bars is not liable to fluctuations, because the heat to which they are exposed is but slightly affected by any variation in the fuel column above them.

The nature of the fuel required depends on the purpose for which the gas is used. If for heating boilers, furnaces, etc., coke or any kind of coal may be used; but for gas-engines, or any applications of the gas requiring great cleanliness and freedom from sulphur and ammonia, it is best to use anthracite, as this does not yield condensable vapors, and is very free from impurities. Gas made by this process, and with anthracite coal, has no tar and no ammonia, and the small percentage of carbonic acid present does not sensibly affect the heating power. A further advantage is, that it cannot burn with a smoky flame, and this is of importance for the cylinder and valves of an engine, and renders it much more easy to apply it to cooking and other stoves than when lighting gas is used. At present all gas stoves are but compromises, for some of the difficulties attending the use of ordinary lighting gas for cooking and heating purposes are so great, that the makers have failed to overcome them. With a gas, however, which requires little air for its combustion, and which cannot give off smoke or cause a soot deposit, these difficulties nearly all disappear.

About seven pints of water and 12 lb. anthracite produce 1,000 cubic feet of my gas, but one-tenth, one-twelfth, and one-twentieth of the gas so made is required to produce and superheat the steam in the A, B, and C sizes respectively of the apparatus used. We have, therefore, an effective production of 900 to about 930 cubic feet, or a mean of, say, 915 cubic feet per 12 lb. of anthracite, allowing 8 to 10 per cent. for impurities and waste. A ton of anthracite produces, therefore, 170,740 cubic feet, of which about half are combustible.

The cost of manufacture depends to a certain extent on the scale of working, and the figures I am about to give you are unfavorable to myself, because they do not represent working on a large scale, when the expenses would be spread over a large production. No skilled labor is necessary, and in practice, where a single generator is required, it is usual to employ a man who has other work to attend to near the generator, and to pay him a small addition to his ordinary wages. A reliable statement of the actual cost of producing the gas in single generators of the three sizes in use, is given in the following Tables, 1, 2, and 3:

TABLE 1.

Generator A size (producing 1,000 cubic feet per hour).

	s.	d.
Anthracite = 12 lb. × 9 working hours = 108 lb. or, say, 1 cwt. at 15s. a ton	0	9
Allowance for wages of attendant	1	0
Repairs and depreciation of generator, gas holder, etc., 5 per cent. on £125 = per working day	0	5
Interest on capital outlay " " "	0	5
Total	2	7

	Cubic feet.
Gas produced	9,000
Less gas used for generating and superheating steam	1,000
Total effective gas for 2s. 7d	8,000

Net cost, say, 4d. per 1,000 cubic feet.

TABLE 2.

Generator B size (producing 1,500 cubic feet per hour).

Anthracite = 18 lb. × 9 working hours = 162 lb.—or, say, 1½ cwt. at 15s. a ton	1	1½
Allowance for wages of attendant	1	0
Repairs and depreciation of generator, gas holder, etc., 5 per cent. on £140 = per working day	0	5½
Interest on capital outlay " " "	0	5½
Total	3	0½

	Cubic feet.
Gas produced	13,500
Less gas used for generating and superheating steam	1,200
Total effective gas for 3s. 0½d.	12,300

Net cost, say 3d. per 1,000 cubic feet.

TABLE 3.

Generator C size (producing 2,500 cubic feet per hour).

Anthracite = 30 lb. × 9 working hours = 270 lb. at 15s. a ton	1	9½
Allowance for wages of attendant	1	6
Repairs and depreciation of generator, gas holder, etc., 5 per cent. on £160 = per working day	0	6½
Interest on capital outlay " " "	0	6½
Total	4	4½

	Cubic feet.
Gas produced	22,500
Less gas used for generating and superheating steam	1,500
Total effective gas for 4s. 4½d.	21,000

Net cost, say 2½d. per 1,000 cubic feet.

From these tables it will be seen that, allowing 1s. to 1s. 6d. a day for the proportion of the attendant's time required for feeding the generator, the total cost of production (including depreciation and interest on capital outlay) is 4s. 3d., and 2¼d. for the A, B, and C sizes respectively, or a mean of about 3d. per 1,000 cubic feet.

The calculated calorific intensity or the pyrometric effect of London gas of the composition before stated is 2,554° C. (4,629° F.), and of my gas 2,308° C. (4,114° F.). The calculated calorific power of 100 liters of the London gas, or the number of grammes of water which they can raise one degree Centigrade, is 559,038, and of 100 liters of my gas 155,836 grammes. From these figures you will see that 3·5 volumes of my gas are required to give the same calorific power as one volume of the London gas, and that therefore we must multiply the cost given in Tables 1, 2, 3, by 3·5, to give that of the equivalent of 1,000 cubic feet of the coal gas. Another practical consideration is that coal gas requires 224 to 250 lb. of coal per 1,000 cubic feet of gas, but my gas requires only 12 lb. per 1,000 cubic feet; and multiplying this by 3·5, to give the equivalent of 1,000 cubic feet of coal gas, we have 42 lb. instead of 224 to 250 lb. This is only 16·5 to 18 per cent. of the weight of the coal required for coal gas; and in reference to the cost of transport, this will effect an appreciable saving in many outlying districts.

Although my apparatus is not very large, I cannot, of course, work it in this hall; but I have here a bag of my gas, and I will show you some of it burning. This is an ordinary Bunsen lamp, and before opening the air inlets I would ask you to notice that when a piece of porcelain or bright metal is held over or in the flame, no soiling or deposition of soot takes place. I will now open the air inlets, and you will see that I can readily heat a piece of platinum, and that, notwithstanding the presence of so much nitrogen in the gas, there is very considerable heat energy developed; in fact, the effect produced is very similar to that obtained with coal gas. This can be explained by the fact that one volume of ordinary London gas requires, theoretically, 5·24 volumes of air for its combustion, and yields 61·3 volumes of combustion products, at the temperature of ignition, whereas one volume of my gas requires 1·2 volumes of air, and yields, at the temperature of ignition, 18·1 volumes of combustion products. If we then multiply the 18·1 by 3·5, we have a total of 63·3, compared with 61·3, as the volumes in each case over which the heat of combustion is distributed. I have not gas enough here to make the experiment, but I may mention that I have fused half a pound of cast-iron in an ordinary Fletcher furnace of small size.

One of the most convincing proofs, however, that this gas has considerable heat energy, as well as uniformity of quality, is the fact that it can be used satisfactorily for driving gas engines. This is no mere opinion of mine, but a fact established by several careful trials made during the past two years with some of the well-known "Otto" engines. At the Smoke Abatement Exhibition recently held at South Kensington, my gas has been in daily use for about three months, to drive an "Otto" engine, working a Siemens dynamo-machine, and some Swan electric lights; and the fact that these lights have been uniformly steady is, I think, a good practical proof that the gas is suitable for engine purposes, and that the quality is constant. I may also mention that the English makers of these engines, Messrs. Crossley Bros., Limited, are so satisfied with the suitability and economy of this gas for their engines, that they are now laying down plant to work an aggregate of 200 horse power with it.

The comparative explosive force of the two gases is as 3·4 to 1—*i. e.*, coal gas has 3·4 times more energy than the Dowson gas. But because the combustion of the carbonic oxide proceeds more slowly than that of the carbureted hydrogen gases, and because the diluents present in the cylinder affect the weaker gas more than the coal gas, in practice with an "Otto" engine five volumes of the Dowson gas are used for one volume of coal gas. Allowing for this, the results of working some 3¼ (nominal) horse-power engines have shown that about 110 cubic feet of the Dowson gas are required per indicated horse power per hour, the indicator diagrams nearly resembling those obtained with coal gas. We have seen that 12 lb. of anthracite produce 1,000 cubic feet of my gas, and that for the A size apparatus 100 cubic feet per hour are required to produce and superheat the steam used in the generator, so that with this size we have an effective production of 900 cubic feet from 12 lb. of coal. From this we see that the above trials, with quite a small engine, have proved that one horse power indicated per hour is obtained with a consumption of gas derived from 1·46 lb. of coal, after allowing for impurities and waste of the latter. The "Otto" engines of larger power consume less gas per horse power than the small ones, and it is not unreasonable to suppose that the result of working the large engines now being prepared for my gas will be a fuel consumption of very little over 1 lb. per indicated horse power per hour.

The economical results are important, as you will see by referring to the following tables, 4 and 5:

TABLE 4.

Working cost of steam-engine indicating 35 horse power, for 2,500 hours (50 weeks of 50 hours each).

	£	s.	d.
Coal = 35 h. p. × 4 lb. × 2,500 = 156·2 tons at 15s.	117	3	0
Water at 2 gals. per indicated h. p. per hour = 175,000 gals. at 9d. per 1,000	6	11	3
Oil and waste at 5s. a week × 50	12	10	0
Wages of firemen at 21s. a week × 50	52	10	0
Repairs and depreciation, 15 per cent. on £380, price of engine and boiler fixed	57	0	0
Interest, 5 per cent. on £380	19	0	0
	£264	14	3

£264 14s. 3d. / 35 h. p. = £7 11s. 3d. per indicated h. p. per annum.

TABLE 5.

Working cost of "Otto" Engine, with Dowson gas, indicating 35 h. p. for 2,500 hours (50 weeks of 50 hours each).

	£	s.	d.
Dowson gas required = 18 cubic feet × 5 = 90 cubic feet per indicated h. p. per hour ∴ total required = 35 h. p. × 90 × 2,500 = 7,875,000 cubic feet, and anthracite required for 7,875,000 cubic feet + allowance of 375,000 cubic feet for superheated steam = 8 250 × 12 lb. = 44·2 tons at 15s.	33	3	0
Water for making gas, say 8,000 gals., at 9d. per 1,000	0	6	0
Water for cooling engine	0	10	0
Oil and waste at 5s. a week × 50	12	10	0
Wages of attendant to feed generator, at 10s. 6d. a week × 50	26	5	0
Repairs and depreciation, 10 per cent on £390 and £170, prices of engine and gas apparatus fixed	56	0	0
Interest, 5 per cent., on £560	28	0	0
	£156	14	3

£156 14s. 0d. / 35 h. p. = £4 9s. 6d. per indicated h. p. per annum.

In Table 4 I have given in detail the yearly cost of working a steam-engine indicating 35 h. p., and consuming 4 lb. coal per indicated h. p. per hour, the number of working hours being 50 weeks of 50 hours each. In Table 5, I have given the yearly cost of working an Otto engine with my gas, during the same time, and indicating the same power. This mode of comparison is, to a certain extent, unfavorable to the gas-engine; for, in practice, an engine has seldom the same load all day and every day, and, with this class of engine, the governor admits only the quantity of gas required for the actual power to be developed. The gas is in fact bottled up, so to speak, in the holder, and is admitted into the cylinder in the precise quantities required. With steam, however, the boiler fires cannot be regulated to suit exactly the varying power required. In practice, the average power may be taken as about one-third to one-half less than the maximum; but, without allowing for this in any way, and supposing that each engine is working up to a uniform power all the year, we find that the steam-engine costs £264 14s. 3d., or £7 11s 3d. per indicated h. p. per annum, and the gas-engine £156 14s., or £4 9s. 6d. per indicated h. p. per annum. This is an economy of over 40 per cent. in favor of the gas-engine when worked with my gas. Moreover, the saving in weight of coal in favor of the latter, compared with the steam-engine, is as 44 to 156 tons = nearly 72 per cent.

I have shown you that this gas can be made very rapidly, and at very low cost, even when produced on a small scale. I have also shown you that it has a considerable heat energy, and that it cannot cause a soot deposit; and I have given you reliable data obtained with actual trials on gas engines. In fact, I have shown you its superiority and great economy, compared with coal-gas, for all purposes of heating and motive power, and I think you will, therefore, agree with me, that for factories, large houses, and public institutions, it has many and great advantages.

For the supply of large towns many other considerations obtain, and there is no immediate probability of great changes being made by the companies who have the legalized monopoly of the pipe-laying, and whose prosperous condition is against the making of radical changes. I think, however, it may interest you to have a few particulars relating to coal-gas manufacture, so that you may better appreciate the general bearings of the case. In the first place, I would refer you to Tables 6 and 7, which show the total cost of making and distributing gas for the four metropolitan and thirteen suburban gas companies.

TABLE 6.

Statistics of Four Metropolitan Gas Companies for 1880.

		s.
Selling price for 16-candle-power gas, per 1,000 cubic feet		3·39
Total gas sold in year—about 18,091¼ million cubic feet.		
Gas sold per ton of coal carbonized—9,529 cubic feet.		
Coke made per ton of coal carbonized—44 bushels.		
Coke used for fuel—26 per cent. of make.		
Per 1,000 cubic feet sold.		
		d.
Cost of Coals		18·43
	d.	
Less residuals—Coke and breeze	5·58	
Tar and products	3·59	
Ammonia and products	2·86	
		12·03
Net cost of coals		6·40
Manufacturing charges:		
Purifying	0·91	
Salaries	0·41	
Wages (carbonizing)	3·58	
Wear and tear	4·93	
		9·83
Working expenses:		
Distribution	2·20	
Rent and taxes	1·38	
Management	1·30	
Law charges	0·11	
Bad debts	0·26	
Public officers, etc	0·05	
Depreciation of works on leasehold	0·02	
Other charges	0·25	
		5·57
Total net cost		21·80

Names of Companies.—Commercial, Gas Light and Coke, London, and South Metropolitan.

TABLE 7.

Statistics of 13 Suburban Gas Companies for 1880.

		s.
Selling price for 14-candle-power gas per 1,000 cubic feet		4·2
Total gas sold—about 2,310 million cubic feet.		
Gas sold per ton of coal carbonized—9,428 cubic feet.		
Coke made per ton of coal carbonized—46 bushels.		
Coke used for fuel—28 per cent. of make.		
Per 1,000 cubic feet sold.		
		d.
Cost of Coals		21·19
	d	
Less residuals: Coke and breeze	6·97	
Tar and products	2·30	
Ammonia and products	2·07	
		11·34
Net cost of coals		9·85

Manufacturing charges:

Purifying	0·96	
Salaries	0 65	
Wages (carbonizing)	4·30	
Wear and tear	5·43	
		11·34

Working expenses:

Distribution	1·80	
Rent and taxes	1·91	
Management	3 21	
Law charges	0·03	
Bad debts	0·24	
Depreciation of works on leasehold	0·21	
Other charges	0·04	
		7·44
Total net cost		28·63

Names of Companies: Barnet, Brentford, Bromley, Colney Hatch, Croydon, Crystal Palace, Lea Bridge, Mitcham, Richmond, Tottenham, Wandsworth, West Ham, and Woolwich.

These tables are based on Mr. Field's well known and carefully compiled analyses of the metropolitan and suburban gas companies' accounts, and I have taken the last year for which these analyses have been published. I have purposely kept the four metropolitan companies separate, because they represent undertakings so huge that certain items of working cost are lower than where the manufacture is on a more moderate scale.

Taking Table 7, which gives the average of thirteen companies, we find that the total net cost of 1,000 cubic feet of 14-candle-power gas sold was over 2s. 4½d., after allowing for the sale of residuals, and without including anything for dividends or interest on the capital outlay. We may then ask: "What probability is there of this cost being reduced by further improvements in the present system of gas-making?"

I think we may assume that the items given under "working expenses" are not susceptible of much change, and we may as well confine our attention to the other headings. In the weight of coals, and in the wages for carbonizing, it is probable that some saving will be effected when cheap generator gas is used for heating the retorts, instead of the present coke fires. It is also possible that the prices realized for about half of the residuals, *i. e.*, for the tar and ammonia, may increase as new discoveries are made affecting their chemical treatment. But after fully allowing for these, we are then forced to the conclusion that, except in localities specially favored, there is no probability of large reductions being made in the present cost. We have, however, seen that there is a growing need for much cheaper gas for heating and motive power, and my own belief is that this need will not be satisfied until we have an abundant supply of gas for such purposes at 1s. per 1,000 cubic feet. To obtain this, however, I also think that the present system of gas making will have to be departed from.

At the meeting of the British Association of Gas Managers, held at Birmingham, in June, 1881, Dr. Siemens gave some interesting particulars of the varying candle-power of the gas produced in ordinary retorts, at different stages of the process of distillation. He showed that, during the first and last stages, the gas given off was of inferior lighting power; and that, for about two-thirds of the whole period of distillation, between the first and last stages, the gas given off was of superior lighting power. From this he argued that the richer gas should be drawn off separately, and sold as lighting gas, and that the gas made during the first and last periods should be distributed and sold separately for heating purposes. It is with some diffidence that I venture to offer an opinion against so high an authority on these subjects; but I think it right to say that I see an insuperable practical difficulty in carrying out this suggestion. Such a system would depend on the consumption of the heating and lighting gases respectively, following exactly the proportions in which each is produced, and how to effect this without serious trouble and complication in the storage and distribution, I fail to see. It was also urged in the discussion which followed, at the above meeting, that the companies would certainly sustain a loss if they continued to manufacture by their present method, and were to sell only two-thirds of their production as lighting gas, and one-third, at a much cheaper rate, as heating gas. Surely it would be simpler and better to make separately, and in distinct apparatus, rich gas, for lighting, and the cheapest possible gas, with coke and decomposed steam, for heating and motive power. The production of each kind of gas could then be easily regulated to suit the consumption.

It has further been suggested that when gas is made solely for heating purposes, it need not be purified at all, or very slightly; but I beg to protest strongly against the adoption of such a suggestion. Tables 6 and 7 show us that the cost of purifying gas for lighting is about one penny per 1,000 cubic feet sold, and such a small saving would never compensate for the loss due to the corrosion of metals and the injury to health which would inevitably follow the liberation of sulphur and ammonia compounds.

That gas for motive power will play a most important part in the future is, I think, beyond doubt; and in confirmation of the views I have expressed on this subject, I would remind you of two important statements which have recently received much public notice. In the first place, so high an authority as the Chairman of Council of this Society has told us in his inaugural address that the "average steam-engines in use throughout the United Kingdom certainly do not give one twenty-fifth of the energy which may be taken as residing in the fuel they consume." He also referred to the excellent work done by gas-engines, and remarked: "There are many temptations to the use of a good gas-engine. There is no fear of the boiler blowing up, no fear of its being injured for lack of water, no stoking is needed, hardly any attention is necessary; and having regard to the great requirement for electrical illumination in clubs, theaters, and even in private houses, there appears to be a very large future for this kind of motor." Then Professor Ayrton has recently shown * that the internally fired gas-engine has a much higher theoretical efficiency than a steam or hot-air-engine. He has, however, pointed out that a gas-engine, burning illuminating gas, is in the same position as was, a few years ago, an electo motor for which, until quite recently, zinc was the fuel burnt for producing the electricity. In his remarks he said: "If it be possible to manufacture a cheap heat-giving gas, small gas-engines driven with such gas will not only surpass in economy steam-engines of the same size, but will produce energy at a cheaper rate per horse power than the largest steam-engines ever made."

It may be that the demand already existing for heating-gas is not sufficient to warrant the gas companies in putting down separate mains, but I feel sure that the question is one of growing interest, and that gaseous fuel will, sooner or later, be one of the important factors in our industrial and domestic arrangements. The apparatus I have described to you this evening is already being used for several manufacturing and other purposes, and for motive power; and it remains to be seen how far the companies who supply gas to towns may find it to their advantage to adopt a modification of the process.

* "On the Economical Use of Gas-engines for the Production of Electricity," by Professor W.E. Ayrton, F.R.S. P. & N. Spon, Charing Cross.

THE MERLIN BICYCLE AND TRICYCLE.

In the engravings we illustrate in Fig. 1 a new form of bicycle, designed by Bricknell, which appears to embody in an eminent degree the three leading qualifications of such machines, namely, safety, power, and high speed. Safety is assured by the small size of the front wheel, which admits of the rider being seated so that he can touch the ground with his feet. The saddle is also placed further back than in the ordinary bicycle, but not so much so as to deprive the front wheel of the weight necessary to make it gripe the ground. At the same time the rider is quite as much directly over his pedals. Power is applied to pedals on the inner ends of two levers, the outer extremities of which work on centers attached to the framework. A strap fastened to each is carried upward and coiled round a small loose pulley on each end of the axle of the driving wheel. On the same axle are fixed two short radial arms, each carrying a silent pawl. When the treadle is depressed the strap draws round the pulley, which engages, by means of ratchet teeth, with the pawl, and so the wheel is revolved. A spiral spring inclosed in the pulley rolls it back, coils up the strap, and raises the pedal for the next stroke. Strokes of any length, from one to twelve inches, can be made at will. High speed is provided by proportioning the parts so that one stroke of the foot turns the wheel five-sixths round instead of only half-round, as in the ordinary bicycle. The 36-inch driving wheel is therefore equal to a 60-inch. Dead points do not exist in this machine. The economy effected in the rider's force is stated to be so considerable that a portion of it is available for conversion into even higher speed than is attainable by the ordinary bicycle, and this permanently, and without the use of cogs, chains, or other frictional devices. The friction in this machine is in fact reduced below that of the common bicycle. It is claimed for the Merlin, in short, that it combines safety, speed, and hill-climbing power to a greater degree than any other bicycle, and as the rider's feet are always within reach of the ground, there is practically no risk in riding or difficulty in mounting and dismounting.

Fig 2 of our engraving represents the Merlin tricycle, which is also Bricknell's patent. The greater part of the foregoing remarks apply equally to the tricycle, the mode of propulsion of the two machines being alike. It has the merit of direct application of power without the intervention of cranks, chains, or gear wheels; so that the increased friction and weight of those appliances are entirely done away with. It is more open-fronted than other tricycles, and the facility it affords for making long or short strokes at will, without alteration of the machine, makes it especially suitable for ladies' use. The wheels are 36 inches, and are speeded up to equal 60 inches, but the power or speed of both the Merlin bicycle and the Merlin tricycle can be regulated by the rider to suit his convenience or the character of the roads in his neighborhood, or the season of the year, by simply employing longer or shorter driving straps, which by being coiled more or less upon the driving drums, increase or decrease their diameters. The width of the Merlin tricycle outside being only 29 inches it passes through any ordinary doorway, and yet the width between the tracks is equal to that of some well known makes. The brake is very powerful; it acts on both wheels and can be relied on in descending very steep hills. The steering gear can be shifted from right to left, or *vice versa*, at the option of the rider, and the machine can be supplied with seat or saddle as preferred. Both bicycle and tricycle are manufactured by Bricknell & Co., Limited, of the Merlin Engineering Works, Brixton Rise, London.—*Iron*.

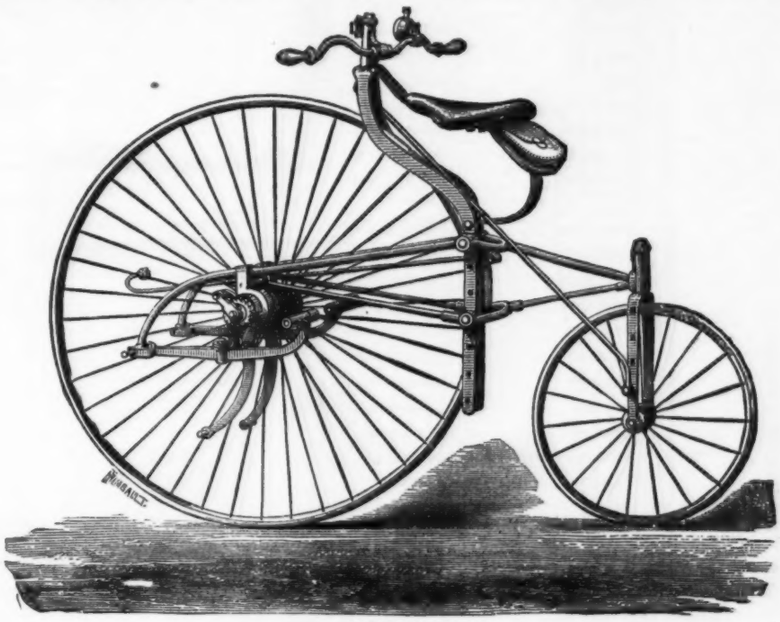


FIG. 1.

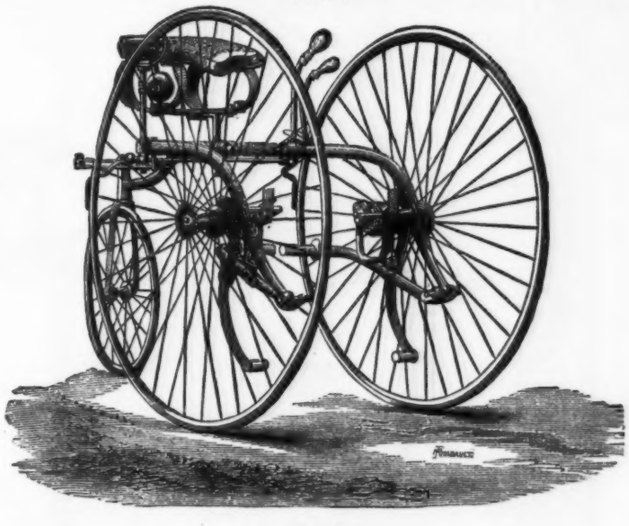


FIG. 2.

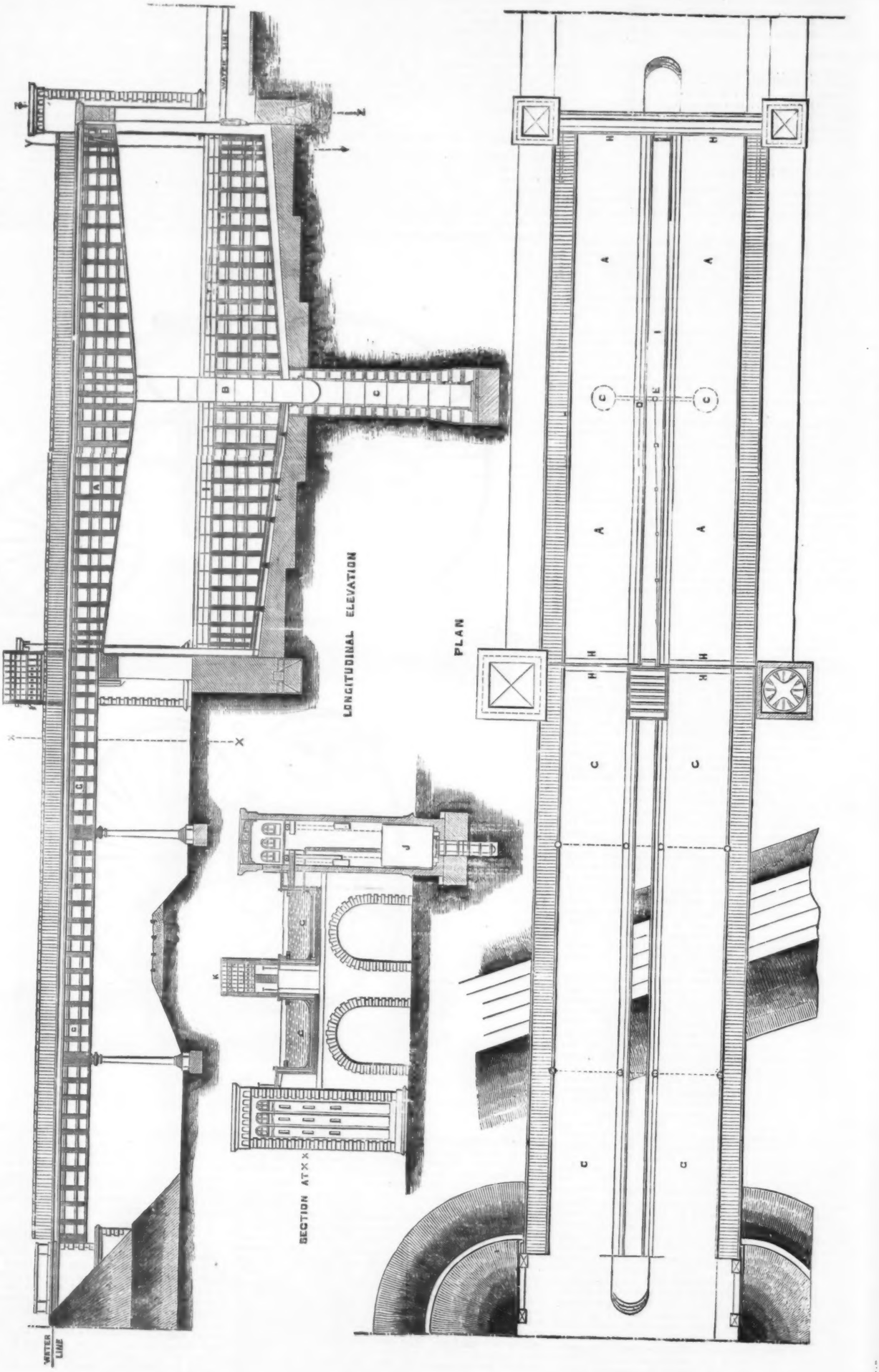
THE MERLIN BICYCLE AND TRICYCLE.

HYDRAULIC TELEGRAPH.

COUNT C. DE MONTBLANC and Mr. L. Gaulard, of Paris, have invented a hydraulic telegraph based on the combined employment of the constant pressure exerted by a column of water of determined height, and on the velocity of flow in a pipe of the same liquid under a given pressure. If by an opening formed in a pipe at a distance of thirty-three feet, for example, below the level of the reservoir which supplies it with water, is introduced a body of slightly smaller section than that of the pipe, and of a weight less than that of the column of water which it supports, it will be displaced with a speed which will be so much the greater in proportion to its weight being so much the less. It is upon these principles that they construct their hydraulic telegraph for the rapid transmission of letters or dispatches, and which is

HYDRAULIC ELEVATOR ON THE NEUFFOSSE CANAL AT FONTINETTE, ST. OMER.

MESSRS. CLARK, STANDFIELD, AND CLERK, WESTMINSTER, ENGINEERS.



specially intended to connect two stations separated by a sea or channel. In putting the invention into practice, they connect the two stations by a tube of a diameter of four inches, for example. This tube is of lead about four-fifths of an inch thick, and is covered with an armor formed of iron wire wound spirally round it, and protected externally by a wrapping of tanned or tarred hemp. This arrangement, while enabling the tube to resist the pressure of the column of water, which, owing to its immersion, it has to support, leaves it sufficient flexibility to allow of its following the undulations of the ground. At each of the terminal stations this tube is put into communication with a water pipe, whose section or bore is at least equal to it, and whose source of supply, whether natural or artificial, is about one hundred and sixty feet above the level of the sea or channel. The communicating tube is connected to the water-pipe by an apparatus composed of a box, which is closed at the top and bottom by sluices or valves, and has in front a water-tight door. The communicating tube and the water-pipe are fitted to the bottom and top of the box respectively. The internal section of the box is greater than the bore of the communicating tube, and it is intended to receive a case or receptacle containing the letters or dispatches to be transmitted. This case is of smaller diameter than the communicating tube, and formed of iron wire rolled into a close coil, and covered by a tight India-rubber casing. Its mouth is closed with a water-tight cover. In working the apparatus both the sluices of the box being closed, the door is opened, and the case containing the letters or dispatches is introduced into it. The door is then closed, and the two sluices are opened; the pressure thus comes into action, and the case is caused to travel through the tube to the other station with considerable speed. The tube at the receiving station must be opened, and the case on reaching it may be allowed to fall into a vessel formed with openings to allow the water to run off. When it is required to dispatch another case the two sluices are again closed, the case introduced into the box, and so on as before.

HYDRAULIC ELEVATOR FOR CANALS.

WE now give illustrations of a new canal lift constructed for the French Government from the designs of Messrs. Clark and Standfield, Westminster, by MM. Cail et Cie, and erected by them on the Neuffossé Canal at Fontinette, near St. Omer. The lift consists of the same essential parts as the Anderton Canal lift, with an improvement which will be referred to further on. The *bacs*, as the French term of them be forcibly depressed, say 40 ft., so as to elevate the other 40 ft., it will be found that a weight of about 38 tons will be required to balance the weight of the head of water under the elevated trough, and the differential work expended in effecting this balance represents a certain waste of power and water every time a barge is lifted or lowered. This, though common to the usual arrangement of lifts, is avoided by Messrs. Clark, Standfield & Clerk, by an ingenious compensator arrangement, which maintains perfect equilibrium of the presses in all positions, and enables them to be used without any loss of power except that due to friction.

As compared with the Anderton lift, the Fontinette loss of water is in the ratio of 1 inch to 5 feet, that is, $\frac{1}{60}$; and by comparison with an ordinary lock, the loss of water is only as 1 in. to 45 ft., that is, less than $\frac{1}{540}$. As previously described, when loaded barges are descending and empty ones ascending, a volume of water equal in weight to the difference between the weights of the descending and ascending barges is raised and passed into the upper canal.

Besides a second series of lifts, which have been designed for the French Government, two series of lifts of somewhat similar dimensions have been designed for the Belgian Government. This series of lifts was designed for passing a canal over a range of hills, between Charleroi and Brussels, where water is not obtainable. The Brussels-Charleroi lift has troughs 5·76 meters in width, 45 meters in length, and 3·06 meters in depth. We need hardly say that these lifts are of very great importance in inland navigation, as they make it possible to carry canals through countries where water is scarce.—*The Engineer.*

ASPHALT PAVEMENTS IN WASHINGTON.

THE following is an extract from Lieut. Green's (U. S. E.) report:

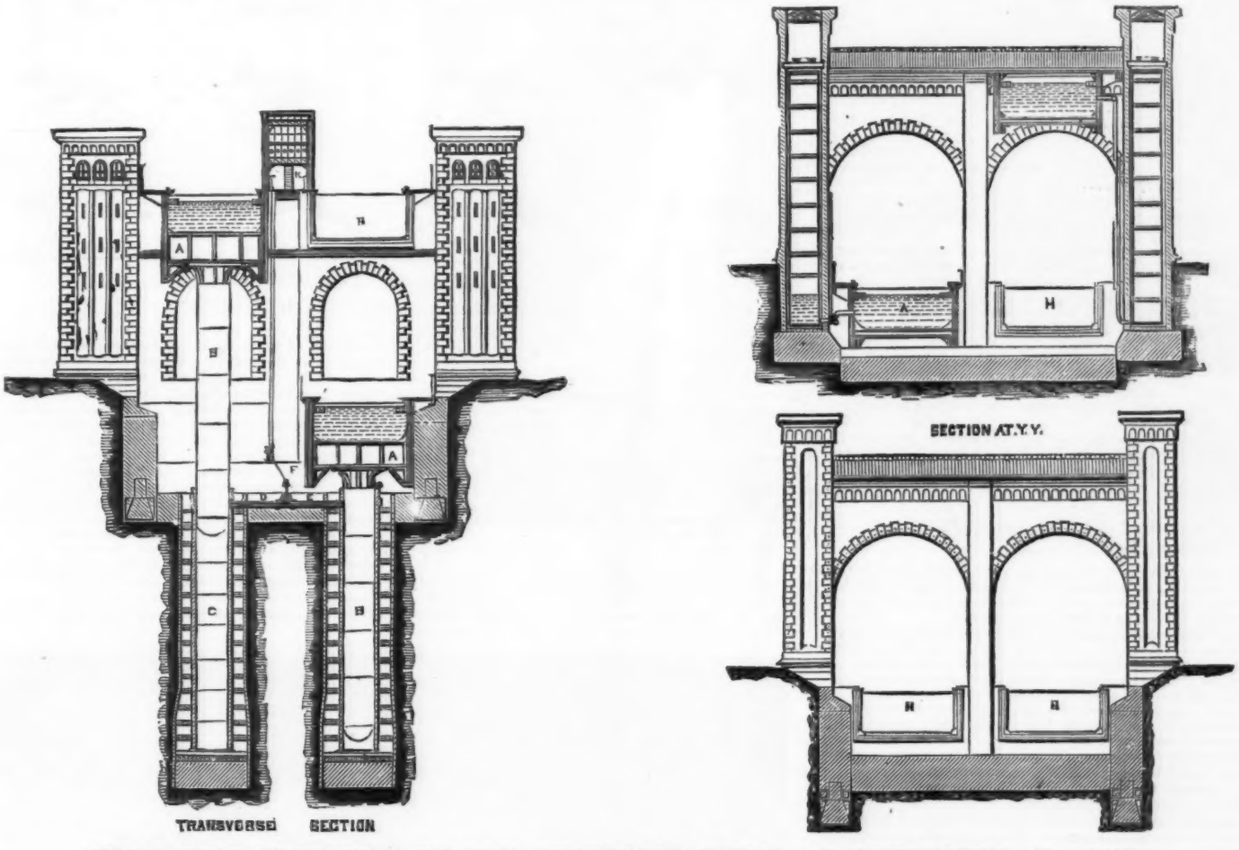
"The asphalt pavement is laid as follows: A foundation of six inches of solid hydraulic cement concrete and a wearing surface of bituminous mastic, laid in two coats, respectively half an inch and two inches thick, when compressed. The mastic is composed of the following parts by weight:

Asphaltic cement (refined Midland asphalt) 100 parts:

Petroleum oil, 20 parts.....	15 to 18
Limestone powder.....	15 to 17
Sand	70 to 65
	100 100

per cent.—the mixture will fuse or run at a temperature of 150°, or even less. The problem is, therefore, to mix these two hydrocarbons in such proportions that the mixture shall neither be brittle nor liquid under the extremes of cold and heat actually experienced on the streets. Up to the present time the proportion of oil has been kept at about 20 to 100, or 16⅔ per cent. None of the pavements laid since 1878 have cracked under the cold (minimum —5° Fahr.) of the two winters since that date. A few of them have, in two or three small places, crept into waves under the heat of summer, as, in spite of all precautions, mistakes will sometimes occur in the preparation or handling of the material.

The mixture of asphalt (*i. e.*, mineral bitumen) and petroleum oil is the cement which binds together the particles of sand, which form two-thirds of the wearing surface and constitute its real resisting material. This cement must be less than enough to fill the voids in the sand, and only enough to bind them together when perfectly compressed. In order to reduce the voids as much as possible, ground limestone powder is added to the sand in the proportion of about 1 to 4. The powder is of such degree of fineness that it will all pass a 26 screen, and 75 per cent. of it will pass a 40 screen. The cement, as previously stated, is added in the proportion of about 15 to 85 of sand and limestone powder combined. The oldest pavement of this class is the one laid by the paving commission of 1876 on Pennsylvania avenue, between Sixth and Fifteenth streets. This has now been on the street between three and four years, and the repairs (made at the expense of the contractors) are understood to have cost $2,142.50, or at the rate of $714.16 per annum, the number of yards being 53,198·80. The annual expense for repairs has been less than 1½ cents per square yard. On the compressed asphalt pavement laid by the Neuchatel Paving Company on Pennsylvania avenue, between First and Sixth streets, the repairs are reported to have cost about $1,867, or $622.33 per annum, the number of yards being 25,322·28. The annual expense for repairs has been about 2½ cents per square yard. This pavement of the Neuchatel Company is of the same character as those laid on the roadways in Paris. It is composed of *natural* bituminous limestone, which is broken and reduced to powder by heat, placed on the street in form of powder, and compressed by large iron rammers. The pavements which we are now laying in this city, under the name of asphalt, are *artificial* mixtures or mastics. Our investigations and practice are therefore on an entirely different line from those in Paris. The objections made to the Paris pavements are well known to be its slipperiness during a light rain or in damp



HYDRAULIC ELEVATOR ON THE NEUFFOSSE CANAL AT FONTINETTE, ST. OMER.

the lock troughs or tanks, are 5 meters in width, 45 meters in length, and two meters in depth. These are balanced upon hydraulic rams, 6 ft. 7 in. diameter, in press cylinders, which are at will in communication. The difference in level at Fontinette is 13·18 meters, or about 11 ft. less than at Anderton.

In our illustrations, on the opposite page and above, A are troughs, B, the rams supporting the troughs; C, the press the cylinder; D, supply pipes communicating with both presses; E, valve above referred to; F, see transverse section rod for working the valve, E; G, permanent aqueducts; H, gates closing the aqueducts and troughs; I, dry reception chambers for the troughs to descend into; J, accumulator; K, valve house. We shall not here describe the whole of the details of this lift, as they are, with one exception, the same as at Anderton, described at length in the above mentioned impression. There is, however, one point to which attention must be drawn. Although the two troughs balance each other, it will be seen that when one is raised or the other depressed, there is an unbalanced head under the higher trough. If left to themselves, the two troughs would, of course, assume the same level. If, however, one

"The specification last year called for 18 to 20 per cent. of asphaltum cement, but experience showed that this proportion made the pavement too soft in summer, and the proportion actually used was between 16 and 17 per cent. The theory of this pavement is a solid base of concrete masonry, practically imperishable, and a comparatively thin and smooth wearing surface, which can be replaced when it is worn out—say every *fifteen or twenty years*. The concrete base is easily made, and satisfies all the conditions. In making the wearing surface, there are some practical difficulties which require constant attention and skilled, experienced labor. The pavement is subjected to a temperature of 150° in summer and —10° in winter, a range of 160° Fahr., at all of which temperatures it is required to present a uniform surface. The danger in practice is that in extreme cold the surface will crack and become friable, and in extreme heat it will become so soft that it will roll or creep under the traffic, and present a wavy surface very uncomfortable to travel on. Refined asphalt is very brittle at a temperature of 60° Fahr., or less; when tempered with the heavy oil resulting from petroleum distillation, it becomes ductile and tough; but if the heavy oil is added in excess—say above 20

weather and the difficulty of cleaning. The contracts for maintenance provide for sanding the pavement when slippery and for flushing it with a large amount of water and scrubbing with a rubber mop or "squeegee" in order to clean it. The same objections apply to the compressed asphalt pavement on Pennsylvania avenue, *while the mastics, as laid here, are almost free from these objections, owing to the gritty nature of the sand, which forms a large portion of the ingredients.* Where cut by plumbers, for making connections with pipes and sewers, *the surface coat does not show ang appreciable wear.* The pavements are all to be repaired at the contractors' expense during the period of five years from date of completion, but as yet no repairs have been necessary except for cuts made by plumbers.

The entire surface of asphalt pavements on a concrete base in this city on the 1st of January, 1881, will amount to 360,000 square yards; of the so-called concrete pavements, of which the cementing substance was a product of coal-tar, the amount is 700,000 square yards, giving a total of 1,060,000 square yards of monolithic or smooth surface pavements, extending over a length of 44 miles. This is considerably more than exists on the roadways of all other

cities in the world taken together—the amounts for other cities being as follows:

	Square Yards.	Miles.
Paris	370,000	193/4
London	150,000	6½
New York	20,000	1
Other cities (estimated)	60,000	2¾
	600,000	30

The so-called *concrete pavements* are, as a general rule, in a fair state of preservation: they are generally laid on a base of broken stone from four to six inches thick, covered with a layer of "binder" about one inch thick, composed of pebbles and a cement of coal-tar. The wearing surface was made in various ways, according to the patent, but consisted essentially of small gravel, sand, or stone-dust, cemented by a product of coal-tar. In the later pavements of this variety a certain proportion of asphalt was mixed with the coal-tar, and with beneficial results. Several of these pavements have stood the test of five years' wear; with little or no repairs, and are to-day in perfect condition; others were of inferior quality. When the top surface has worn off, these pavements begin to go to pieces very rapidly, and in order to save them from destruction they must be promptly covered with a new wearing surface. During the year 1879–80, 53,436 yards were thus resurfaced; and 17,863 yards were entirely condemned, taken up, and replaced with the standard asphalt pavement on a concrete base. During the current year about 15,000 yards have been resurfaced or are under contract.

Experience has, however, shown that by careful attention and constant repairs of small quantities in each, these pavements can be made to last much longer than was anticipated. Pavements, for example, which seemed on the point of destruction two years since have, by constant patching, been maintained up to the present time and still present good surfaces. These pavements, however, were all laid within a few years of each other, and there is a possibility that after a few years more of wear they might all break up at the same time, during a severe winter, for example. It is, therefore, economical to gradually resurface a certain portion every year, and an appropriation of about $100,000 should be made annually for this purpose. A summary of these pavements is shown in the following table:

	Square Yards.	Cost.
Laid 1871–75	741,415·44	$2,284,004 91
Resurfaced, 1875–78	218,842·69	329,378 69
Resurfaced, 1878–80	53,436·33	59,187 40
Replaced, 1879	17,863·75	29,691 90
Minor repairs, 1875–78	.....	3,099 62
Minor repairs, 1878–79	.....	18,618 22
Minor repairs, 1879–80	.....	8,206 26
Total for repairs	.....	$448,182 09

These repairs extend over a period of seven years, *i. e.*, from 1873, the average time of laying, to 1880, and the average annual expense of repairs is, therefore, $64,026, or at a rate of 8½ cents per yard. This is certainly not an expensive rate for the luxury of smooth pavements. The asphalt pavements being composed of less perishable materials, and being laid in a more substantial manner, it may be confidently expected that the cost of maintenance will be still less.

The minor repairs of concrete and asphalt pavements are made by contract let to the lowest bidder, and running for one year. These repairs include the damage done to pavements by plumbers' cuts, the actual cost of which is paid by the plumbers. The work to be done is specified by this office, and the whole city is carefully examined and repaired about four times a year, or oftener, if necessary. The work is done under careful inspection of experienced inspectors employed by the district.

SAVING LIFE IN CASE OF FIRE.

To the Editor of the Scientific American:

Knowing the wide circulation of your paper, I ask for a small space in its columns to lay before your readers, especially in large cities, my views regarding improved methods of lifesaving in case of extensive fires.

The inadequate means of saving life, when fires suddenly break out in high buildings even at midday, as evidenced at the burning of the *World's* building, New York, appeals to humanity for new appliances which shall make the saving of life from fire, when the would-be victim is in sight, a matter of almost absolute certainty. A consideration of the agony endured not only by the victims, but by all the witnesses of their sufferings, has led me (as it has doubtless hundreds of others) to try and devise some means by which the inmates of burning buildings can reach the ground in safety through the windows, when their descent is cut off within the building by the flames.

Permanent fire escapes attached to buildings have been devised without number, but no amount of legislation or regard for the life of tenants on the part of owners has as yet secured their general use; even where they have been applied to buildings they have proved like the life preservers on many vessels, of no value in time of need. I would place the means of rescue in the hands of cool-headed, intrepid men, like those composing the fire departments of large cities, and not rely upon the half crazed inmates of a burning building making use of appliances for escape, which, even in cooler moments, they could not have made effectual.

The rescues effected through the agency of the poor bootblack, in the case mentioned above, have furnished a clew which, if properly followed, will, I think, lead to valuable results. Let a detail from each fire company act as a life saving crew in time of need; they should be furnished with a mortar, similar in character to those used by life-saving crews on the sea shore; these should be charged with sufficient powder to throw a slender wire rope over the loftiest building; the mortar should be so trained that the rope may pass over the building directly above the window from which the rescue is to be effected; this rope could then be made the means of placing a rope ladder before the windows, when a few seconds' work on the part of skilled firemen would place the inmate beyond the reach of danger.

The mortar could be charged and fired with great rapidity, and a very few moments should suffice, by the aid of these appliances, to place all the endangered people on the ground in safety, even were the building as well tenanted as was the *World's* building, New York.

The line and ladders should be made of wire, so as to withstand intense heat for a few moments if exposed to it.

I make these suggestions, hoping that others more familiar with fire service in large cities may elaborate the views contained therein, and perfect the details of a plan which will, I think, prevent a repetition of such scenes of horror as were enacted at the fire referred to above.—Yours, truly,

C. B. KOON, C. E.

Lincoln, Neb., March, 1882.

SAVING LIFE AT FIRES.

To the Editor of the Scientific American:

In view of the great loss of life during fires in large and high buildings, through the inability of establishing communications with the upper portions of such buildings, the idea suggested itself to me of employing the *rocket system*, such as is in use on the coasts, for the purpose of shooting over on to the roofs of buildings wire ropes or chains, suitably weighted with any device to catch on projections or pierce the roofs. A rope once fixed in this way could be used for a great many purposes. Hand and foot catches could be made to enable firemen to easily ascend or descend such ropes, or a messenger, similar as is used by boys on kite strings, could be constructed with suitable pulley attachments that could be forced up the rope by means of a stream of water from the engine, by which hose, ladders, etc., could be quickly hoisted.

I called upon our experienced chief of the S. F. F. D., Mr. David Scunnell, who thought it a good suggestion to make to you. As it would necessitate a special service, he thought it would not be essential in our city of low houses, but approved of the plan in cities where large buildings predominate. If you think the suggestion worthy, please make it public through your valuable paper.

L. R. FULDA.

San Francisco, March, 1882.

INSTANTANEOUS PHOTOGRAPHS.

ABOUT three years ago we made known to our readers the surprising results that had been obtained in the instantaneous photographing of a horse's motions by Mr. Muybridge, of San Francisco; and, by the kindness of that operator, we were enabled to reproduce at the time, by heliotype, a series of photographs representing a trotting horse in his successive positions. These engravings attracted considerable attention, and were reproduced last winter at Paris, when Mr. Muybridge exhibited projections of his photographs at the residences of Messrs. Marey and Meissonnier, and at the Artistic Union, Place Vendome. By means of a projecting zoötrope he passed over a screen images of his photographs reproduced on a circular disk, so that there could be seen on the canvas dogs and horses running, men walking, acrobats jumping, etc.

Mr. Muybridge has obtained a considerable number of negatives, which represent an enormous amount of work, great patience, and consummate dexterity. One of his photographs is taken in less than 1-500th of a second, so that it is easy for him while an acrobat is making a somersault to obtain his portrait eight times in the successive positions that he occupies in space, and this by means of several different photographic apparatus whose objectives are successively uncovered in an extremely short interval of time.

The motions of animals form a very novel and curious collection. In Fig. 1 we give an engraving of photographic proofs representing the different positions of a greyhound running at full speed. It is remarkable to observe how the legs are gathered up under the body to afterwards stretch out like a spring. Photography allows us to study here what the eye does not allow us to see—the analysis of a motion beyond the reach of vision. It will naturally be asked how Mr. Muybridge has been enabled to obtain such results. We take pleasure in again explaining the matter to the reader by reproducing, from a photograph, the general arrangement of the apparatus that the able operator made use of in California, on the grounds of Mr. Sanford. The animal in motion whose photograph is to be taken passed over a track that is seen to the left in Fig. 2, and, in doing so, breaks a series of very fine threads which are stretched near the surface of the ground. Each of these threads, on breaking, brings about, through a simple mechanism, the closing of an electric circuit which acts upon electro-magnets, and the latter attract metallic lever arms which uncover the objectives of the corresponding photographic apparatus. Our engraving shows to the right the shed under which are arranged side by side twenty-four cameras, which operate when the animal, passing in front of them, breaks the threads. To the left is shown a large white screen which serves to throw the animal in strong relief. While the twenty-four cameras are successively operating automatically, four others are likewise obtaining a three-quarter view of the animal, on the right and left, in front and rear. In the cut, three of these apparatus are in place, and the track is shown before operations begin, and just at the moment the assistants are seeing whether everything is ready to work perfectly.—*La Nature.*

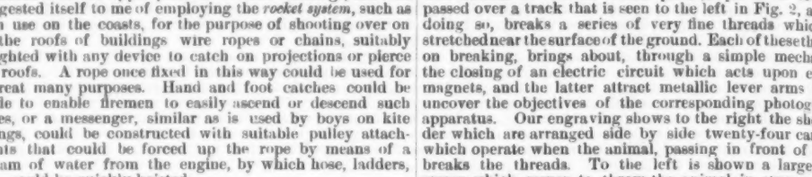


FIG. 1.—GREYHOUND AT FULL SPEED.

(From an instantaneous photograph by Mr. Muybridge.)

PHOTOGRAPHY BY THE ELECTRIC LIGHT.

By H. VAN DER WEYDE.*

OVER six years ago, I was challenged, during a foggy November day, by a desperate London photographer, to invent a method of taking good photographs without daylight, or, as he jocularly put it, "Why don't you Americans bottle your daylight, and send it over to us?" and he assured me there were "millions in it." I don't know whether it was the prospect of "millions," or the great pleasure I have always felt in overcoming difficulties, that induced me to lay aside my palette, and turn my studio into a laboratory. I think my feelings were a little mixed. I had already invented an improved model for building glass-houses, on the principle that every pane of glass visible to the sitter should face him at an exact right angle; and placing the glass in the zigzag crossing of imaginary diverging lines from the usual sitter's place at each end of the studio, effected this.

In looking at the results of all former attempts at taking portraits by artificial light, kindly shown me by the late Wharton Simpson, who was then editor of the *Photographic*

* A paper read at a special meeting of the society of Arts.

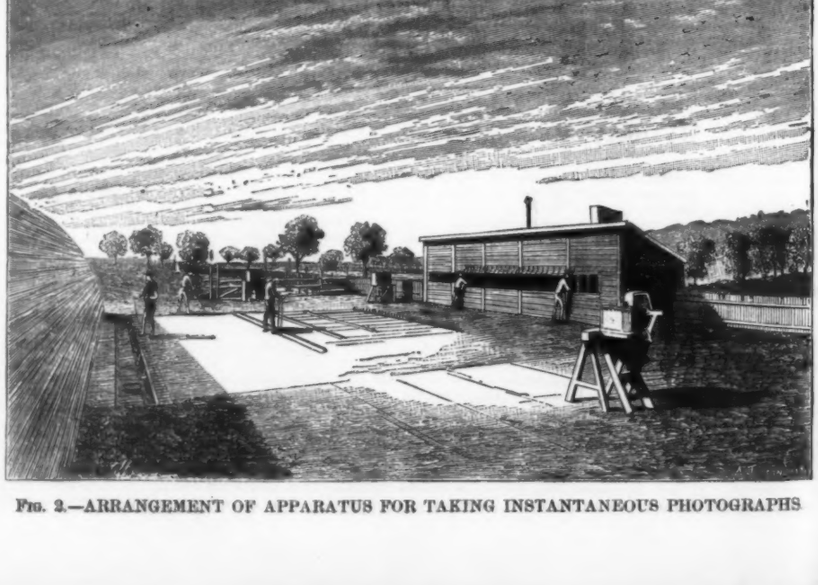


FIG. 2.—ARRANGEMENT OF APPARATUS FOR TAKING INSTANTANEOUS PHOTOGRAPHS.

News. and, I think, a member of this society, although I found some very remarkable, they were all, from an artistic point of view, failures; even the best results suggested a metallic or varnished surface, with glittering high lights, dense shadows, and ghastly reflections.

Instead of attempting to do anything better with artificial light, I first tried to condense the actinic rays of London daylight—when I could catch them—for which purpose I constructed a plano-convex water lens out of two large plates of glass, one bent by heat to the depth of eight inches, which had to be repolished by hand. I believe it was the largest lens ever constructed; it measured six feet and six inches in diameter, and held nine hundred and eighty-seven pounds of filtered water—and the first time I tried to fill it, not having calculated upon the immense weight of this water, although the glass was three-quarters of an inch thick, it burst over me with a loud explosion, and I was overwhelmed, but, as you perceive, not quite drowned, though the point of one of the flying pieces of heavy jagged spears of glass pierced through my forearm, between the bones, and laid me up for six weeks; but that is only a detail in the life of an inventor. So I set at it again, reconstructed my lens, and finished this experiment with a conviction that I was on the wrong track.

I then began experimenting with artificial light, such as the magnesium and the electric light from a Grove battery. I constructed a copper reflector with a silver lining, and having had enough of the water lens, ordered the largest dioptric lighthouse lens that could be made; the reflector and lens were each over four feet in diameter.

It now occurred to me that the great difficulty to be overcome had not been an inadequate quantity of artificial light, but that the construction of the relative position of its rays is diametrically opposite to that of daylight. In daylight we are flooded with a soft embrace of converging rays giving soft-edged shadows; in artificial light we are struck with the sharp darts of diverging rays from a point throwing sharp-edged shadows; and in trying reflectors to lessen this hard effect, we only made a war of rays around the sitter, in which the direct rays always have the best of it, and overexpose the high lights before the others have had sufficient time to perform their part. The question was not to discover a better artificial light, but to turn and twist its diverging rays from a point, so as to concentrate them, and, so to speak, make them embrace instead of strike the sitter. This was the supreme difficulty I had to conquer.

In continuing my experiments, I sought to obtain, first, parallel rays from the parabolic reflector, and then to condense them into converging rays by the dioptric lens; and I at this time adopted the most important point in my invention; it was a small saucer, or concave mirror, about four inches in diameter, placed close to the light, so as to hide it from the sitter, and prevent any direct rays from leaving the reflector. But I found that the silvered interior of my reflector was a mistake. It not only condensed all heat rays, and baked the sitter, but it also polarized the light. So I whitewashed the interior, and from that moment I saw my hopes realized, for I produced at last an artistic portrait with tender crisp high lights, which did not need retouching, and was full of modeling and transparency in the shadows. I tried to do without the condensing lens, but found my light not powerful enough; and it was not until I used a powerful dynamo machine, worked by an engine, that I could dispense with it.

I now went to my friend who told me there were millions in it; but he, and all other photographers in London whom I approached, were too skeptical to invest; they refused the millions or any share in them, so that I was compelled to exploit the invention myself, and with that view bought the lease of my present house, now nearly five years ago. Its slate roof, ladies and gentlemen, is still intact, and I intend that it shall remain so.

The first instance on record of gas being literally turned into electric light was at my establishment. I had my gas-engine put up, September, 1877, in direct opposition to the advice of the manufacturers of my electric machine. I never use an electric lamp, but, as you see, have invented a much more practical arrangement for my purpose. I simply bring my carbons together by a movement of the hand. The positive 20-millimeter carbon is stuck right through the saucer, and can be pushed in from time to time as it burns. The negative 15-millimeter carbon, fastened in a rod which passes through the back and center of the reflector, is also adjustable. The saucer and positive carbon being fixed to a flexible brass rod, can be made to approach the other carbon by simply pulling the cord attached, and which passes through the back of the reflector, and over a small drum. I first designed another position for the carbons, but on the same principle, but find this better, as the reflector gets the full benefit of the strongest rays.

If there are any photographers here who wish to know whether they can make use of my invention in this country, my answer is yes. Two of the richest members of the profession, I understand, make use of it in London, and such being the case, all others are quite welcome to it. The leading photographers on the Continent are not only using my invention, but are good enough to recognize the inventor.

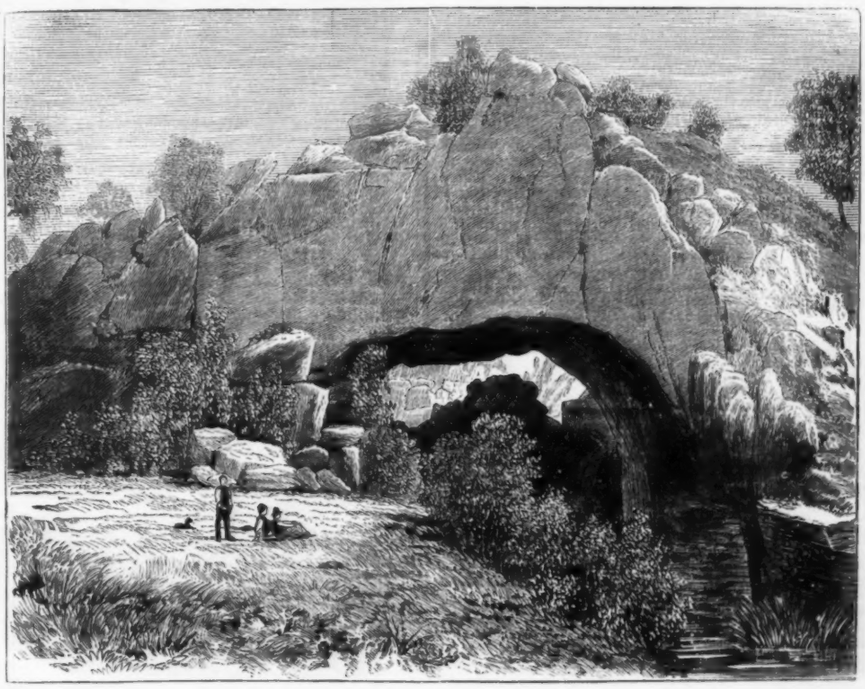
So, gentlemen, I continue to photograph without daylight—in fact, I never took, and never will take, a photograph by daylight.

ON THE INFLUENCE OF THE STEEP WATER ON MALTING.

IN former days it was supposed that the main object of steeping grain prior to germination was to completely saturate it with moisture; the operation of steeping also tends to cleanse and purify the grains, and to remove some objectionable matters from the husk, but prolonged steeping extracts certain constituents from the grain, and is therefore productive of a loss. It is only during recent times that any regard has been taken to the influence of the quality of the steep water on the resulting malt. As a rule, soft waters have been preferred by maltsters, although in some malting districts in the Midland Counties, where very fine malts are produced, the water is exceptionally hard. Experiments have, however, proved that the presence of small quantities of saline constituents exerts an appreciable influence on the malting process. The experiments of Dr. Mills and Mr. Pittigrew, given in a recent number of this journal, show clearly that the saline constituents of a steep water are of considerable importance. These investigators found a very hard water prevented the escape of albuminoid constituents, but extracted a larger quantity of other constituents; it was therefore suggested that the operation of steeping should be conducted in such a manner as to supply sufficient moisture to the grain without allowing anything to be extracted. There ought to be no practical difficulties in the way of this; the modern mechanical appliances for cleaning grain have been so perfected that, with their use, the ordinary washing of the grain, which was considered one of the essential objects of steeping, may now be dispensed with. Steeping, then, becomes a process simply of saturating the grain with a sufficient quantity of moisture; but as the presence of some salts in the steep water have been found to hasten the germination of grain, while others retard this action, the study of the influence of such salts becomes a matter of practical importance to the maltster. In this direction alone there is much scope for further inquiry.—*Brewer's Guardian*.

NATURAL BRIDGE, BOREE CREEK, AUSTRALIA.

THE remarkable natural bridge of which we give an illustration, spans Boree Creek, about ten miles beyond the town of Orange, and in the vicinity of the Canoblas Mountains. It is one of several groups of caverns hollowed by the action of the water out of the limestone hills which form a distinctive feature of this district. The arch has always been called the Boree Natural Bridge, taking its name from the Boree Station. Of late years it has become a favorite picnic ground for the people around Orange, but perhaps not many who visit it know that more pretentious caves exist higher up the water-course. To the left hand of this arch, after entering it, you may find some caverns, and walk by torchlight through several before reaching the open air. To the right, also, an opening may be entered by adventurous spirits, who will have to proceed through the tunnel with one foot on each side of a deep narrow gorge, through which the water runs. This tunnel leads also to daylight on the opposite side of the hill. Water is never failing here, and of a beautiful clear, blue color. In times of heavy rain fall, great floods occur—a tale which the arch itself silently tells. When last we visited this spot it was rendered far less romantic by a shepherd's hut and yards in its close proximity; goats were skipping about the jagged pile of bowlders under the bridge, while a damsel from the station was washing clothes in its shade by the once crystal pool. Nothing can positively destroy the natural rugged beauties of this arch; still one can only feel in looking at it that huts, sheep-yards, and all such prosaic objects, should never have been brought within view of it.—*Illustrated Sydney News*.



NATURAL BRIDGE, BOREE CREEK, AUSTRALIA.

FALLACIES ABOUT LUCK.

By RICHARD A. PROCTOR.

SEVERAL correspondents write about the question of luck, some asking whether the evidence does not show that some men really are exceptionally lucky (so that their luck in matters of pure chance may be relied on); others asking whether, if a coin had been tossed a great number of times with the same result (head or tail) in one set of trials, it would not be more likely to show the other side (tail or head) oftener in the next set of trials; while yet others consider that the ideas of men of science about fallacies generally are erroneous—that, in fact, the so-called fallacies are real truths.

Taking the last first, I may note that the rule of science in all those cases in which specific results are popularly supposed to follow from specified actions, or the like, is simply to inquire whether there can possibly be any relation of cause and effect in such cases. When a housemaid says, for instance, that putting the poker across a fire makes the fire burn up, the student of physical laws is able at once to see that the supposed influence is antecedently most improbable. Here in a grate are certain more or less combustible materials, and certain quantities of matter already burning; combustion is going on, though indifferently; the air is nourishing this slowly burning fire, but inefficiently; on the whole, it seems likely that the fire will go out. In what way shall I do any good if I stick a rod of iron from the fender across the top bar? I thus add a certain quantity of cold metal to the space across which the air has to come to the fire. Do I increase the draught? On the contrary, so far as I produce any effect at all on the draught, I must diminish it. For the draught depends in the main on the diminished density of the warmed air in the neighborhood of the fire, and the cold metal must to some degree increase the density of this air by cooling it. The effect may be very slight, but, such as it is, it is unfavorable. But here is a correspondent who tells me that whether theoretically the poker should make the fire burn up or not, as a matter of fact it does. Repeatedly he has tried the experiment, and after exhausting in vain every art he possessed to make the fire burn up, he found the poker put across the top bar, immediately, or almost immediately, produce the desired result. Science is bound to listen to evidence of this kind, for science deals with phenomena, and even when phenomena seem to point to something which appears utterly incredible, science has to inquire into the matter. Well, in this case, what are the facts? Some one tells us that he has repeatedly tried in vain to make a fire burn up, but when he put the poker across it, the fire presently became clear and bright. Multitudes of contrary cases might no doubt be cited, but let us suppose that none could. Are we therefore to infer that in these cases the poker drew the fire up? A new law of nature would be indicated, if this were so; and a new law of nature is worth learning. But when due inquiry is made, it appears that there is no such law—as, unfortunately, we might have expected. Our correspondent, who found that when he put the poker across the fire it drew up, is unquestionably but an unskillful fireman. He puts on coals, and pokes and stirs the fire, unconscious of the fact that this is just the way to put a fire out. When the fire is all but hopelessly reduced by his unskillful measures, he puts the poker across the top bar. According to old-fashioned superstitions, he makes the sign of the cross across the fire-place, and the fire, in which until now there seemed to have been some evil spirit (that is what people mean when they say "the devil's in the fire"), is purified from the unclean presence and begins to burn up. That would have been the old fashioned interpretation of the change; unfortunately, science takes another view of the matter. It sees reason to believe that the change took place simply because the disturbance to which the fire had before been exposed was bad for it. Putting the poker across the top bar meant letting the fire alone, and giving it a chance to burn up.

Singularly enough, I had occasion, when the last sentence was just finished, to leave my study. When I came back, an hour later, I found that my fire, which in the meantime must very nearly have gone out, had been recoaled—and the housemaid, or whoever had attended to it, had, after the fashion of her tribe, put the poker across the top bar. The fire was not burning very brightly—on the contrary, it seemed inclined to go out. Yet, rashly daring, I put the poker down—from scientific principles I object to seeing bright metal smoked and dulled—and went on with my work, intending, if the fire went out, to call some one in to light it again. However, it so chanced that after the poker was put down, the fire began to burn pretty brightly, and as I write there is every promise of a good fire. Am I to infer that taking the poker from across the top bar made the fire burn up? Of course, the real fact was, that when the fire seemed dull it was really making steady progress, and whether I had taken down the poker, or supplemented its salutary action by putting another poker across the top bar, would have made not one particle of difference.

That our domestic servants should consider the poker across the top bar a specific for making a dull fire burn up is very natural. Their manner of treating fires is unscientific in the extreme. A Cambridge Fellow, who knew very little about the fair sex, except what he might gather from the ways of "bed-makers" and his recollections, perhaps, of domestic servants at home, used to define woman as "an inferior animal, not understanding logic, and poking a fire from the top." Most servants do this. They also have two utterly erroneous ideas about making up a low fire—first, that the more fuel is put on the better; secondly, that after putting coal on it is desirable to stir the fire. As a matter of fact, when a fire is low, the addition of fuel will often put it out altogether, and the addition of much fuel is almost certain to do so; and in every case the time to stir the fire (when low) is before coals are put on, not after. Generally it is well, when a fire is low, to stir it deftly, so as to bring together the well-burning parts, and then to wait a

little, till they begin to glow more brightly; then a few coals may be put on, and after awhile the fire may again be stirred and some more coals put on it. When a low fire has been unwisely treated by being cooled too freely, and the fresh fuel uselessly stirred, it is generally the case that the only chance for the fire is leaving it alone. Susan does this when she puts the poker across the top bar, and unconsciously she retains the old superstition that by thus making the sign of the cross over the fire, she sends away the supposed evil beings or sprites which were extinguishing it.

That letting the sun shine on a fire puts it out is not, like the other (in its real origin, at any rate), a superstition, but simply an illusion. A correspondent writes that it is believed in by nine persons out of ten; but in this it is like all other wrong beliefs. Scientific methods of inquiry and reasoning are followed by fewer than ten in a hundred; and although nowadays the views of science are accepted more widely than in olden times, this is simply because science has shown its power by material conquests.

I do not think that my friend Professor Tomlinson's experiments on the burning of candles in sunlight and in the dark would be regarded by all as decisively showing that sunlight does not interfere with combustion, though, rightly apprehended, they go near to prove this. But *a priori* considerations show conclusively that though by warming the air around a fire the sun's rays may, in some slight degree (after a considerable time), affect the progress of combustion, they cannot possibly put the fire out in the sense in which they are commonly supposed to do so; in fact, a fire would probably burn somewhat longer in a room well warmed by a summer sun than in a room from which the solar rays were excluded. (The difference would be very slight.)

As to fallacies about luck, the supposition that after a great number of heads in fifty tossings, the next fifty would probably show a smaller number, involves precisely the same error (diluted by being spread over a larger space, but not diminished in amount) that I dealt with above. How can the number of heads in one set of fifty tossings affect the number which shall appear in the next? Science says *on a priori* grounds, "Not at all." Experiment repeats as emphatically (it could not say so more emphatically), "Not at all." But then, says the querist, how is it that, as science assures us, there is always in the long run an approach to equality in the number of heads and tails tossed in a great number of trials? If the balance always tends to the horizontal position, surely a movement of one scale upward should assure us that presently the other scale will begin to rise. Equality is indeed brought about in the long run, but not in the way imagined. Absolutely not the slightest influence is produced on the results of one set of, say, a hundred tossings, by the observed results of the next preceding set (how *could* there be?). Nor is there any tendency in a very long series of tossings, starting from some particular point, to reduce a discrepancy between heads and tails, which had attained any amount up to that point. On the contrary, if we count from and after that point, as well as if we count from and after the absolute beginning, we shall find the same tendency to equality in the results of a great number of tossings. The excess of heads over tails, or of tails over heads, may go on increasing, and yet there is the tendency to equality which science indicates. This sounds paradoxical, but it is what science teaches and what experience confirms. It is demonstrable that the greater the number of trials of coin tossing, the nearer will the *ratio* of heads to tails approach to equality, though the actual excess of one over the other may probably be greater, and possibly much greater, than in a smaller number of trials.

Take a very simple case. Suppose a coin tossed four times, and consider the chance that there will be either two more heads than tails, or two more tails than heads. There are in all 2^4, or 16 possible events. That there may be two more heads than tails, three heads must be tossed, which can happen manifestly in four different ways, for the first, second, third, or fourth toss may give the single tail. So, also, there may be two more heads than tails in four different ways. There are therefore eight ways (out of 16) in which either heads or tails may show three times as against one of the other kind. The chance is therefore one-half, or it is an even chance, that there will be this degree of discrepancy. On the other hand, there are only six ways in which there can be two heads and two tails, for only six pairs can be made out of four (the first tossing may be head, as also second, third, or fourth; the second may be head, as also third or fourth; the third may be head, as also the fourth; and these arrangements of two heads give also all the arrangements of two tails). Thus the chance of absolute equality is only 6-16ths, or 3-8ths, that is, the odds are five to eight against absolute equality, while the chance that there will be a difference of two exactly between the heads and the tails is one-half. (The chance that all four will be of the same kind is, of course, 1-8th.)

Now, compare with this the results we get when, instead of four, there are eight tossings. Here there are 2^8, or 256 possible events, and it can readily be shown (but I leave this and the general problem to a series of papers which I shall hereafter write on probabilities) that the chances of the different results, and the odds respecting them, are as follows:

	Chance.	Odds.	
All heads or all tails.....	1-128th..	127 to 1	against.
All but 1, heads, or tails...	1-16th...	15 " 1	"
All but 2, heads, or tails...	7-32ds....	25 " 7	"
All but 3, heads, or tails...	7-16ths...	9 " 7	"
Four heads and four tails..	35-128ths..	93 " 35	"

The most probable of all events in this case, as in the last, is that there will be two more heads than tails, or *vice versa;* and whereas in the former case it was an even chance that there would be just this discrepancy, the odds in the present case are nine to seven against it. But the chance that there will be this discrepancy *at least* is greater with the greater number of trials. For in the former case the odds were but five to three, or 175 to 105, against absolute equality, in the present case they are 93 to 35, or 279 to 105 against it. And it can be shown that it becomes less and less likely the greater the (even) number of tossings that there will be absolute equality. Yet, on the other hand, in the cases considered, the chance that heads will exceed tails, or tails heads, not by a given amount, but in a given degree, diminishes as the number of tossings is increased. Thus with four tossings, the chance that heads will be to tails as three to one (or *vice versa*) is, as we have seen, one-half; with eight tossings the chance of this relation holding (six of one kind, two of the other) is only 7-32ds. Again, the chance that heads will be to tails, or *vice versa*, in a ratio of not less than three to one is 5-8ths in the former case; in the latter (adding together 1-128th, 1-16th, and 7-32ds) we find it to be only 37-128ths; in one case the odds are five to three in favor of that amount of discrepancy at least, in the other they are 91 to 37 against there being a discrepancy so great.

But some correspondents ask whether, even in matters of pure chance, there may not be something more than mere accident—whether some men may not have a certain degree of good fortune given to them—whether, in fine, what is called luck may not in some degree depend on Providence. This takes us a little outside the domain of science; but as it does not bring us upon any of the vexed questions of dogmatic religion, I will venture to make a remark or two on this (in reality) unscientific aspect of the question. To the student of science it appears as absurd to imagine that the laws of nature would be set on one side in matters of pure chance (for even in coin tossing nothing short of a miracle can cause the law of averages to be departed from—in the long run—either in favor of any one or against him) as it would be to conceive that an experimenter favored by Providence might get a mixture of carbonic acid gas* and nitrogen to behave like a mixture of oxygen and hydrogen, or as it would be to suppose that during Darwin's researches into the work of earth-worms, these creatures, *suadente diabolo*, acted in a way not natural to their kind. If in the case of so-called lucky gamblers, a supernatural power, good, bad, or indifferent, has been at work, science has no power of dealing with the phenomena. All science can say is, that the observed and recorded phenomena agree precisely with those which can be shown to be necessary consequences of the laws of probabilities; all she can do is to go on dealing with the matter precisely as a Pasteur would go on dealing with the observed phenomena of disease germs, uninfluenced by any suggestions that diseases were produced by supernatural agencies.

So far, I have simply considered what science necessarily does in such cases. The student of science can do no otherwise. But I may note, in passing, that just as there seems to be something irreverent in the suggestion of Providence arranging for the "breaking of the bank" by a Garcia or any other unprincipled gambler, so the general suggestion that Providence, and not the laws which have been assigned to the universe (how or why we know not), is to be credited or discredited with all the chances or coincidences which seem surprising to us, appears to me singularly dangerous to the faith of the weaker minded. Because, while many of these coincidences have been satisfactory enough in their results, at least as many have been very much the reverse, and not a few utterly deplorable.

Take for instance the following case:

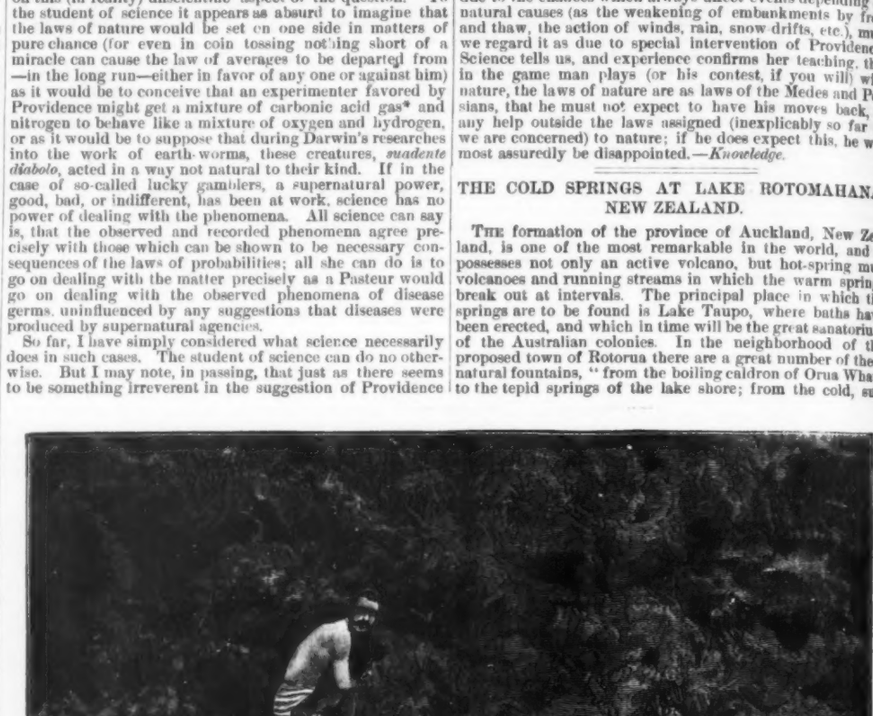
In the winter and early spring of 1881, in America, railway accidents were very common (231 happened in the first two months of that year), and any one who had (as I had) much railway traveling to do at that time had a very fair chance of coming in for wounds and contusions, if not worse.† Now it so chances that at the end of February, a train was wrecked in Missouri, in which two persons were killed and many injured. Another train was sent, carrying several medical men, and a number of appliances for the relief of the wounded. By a most unfortunate chance, this train, thus forwarded to help many suffering persons, was itself wrecked; seven persons were killed, including several of the doctors. If we are not to consider this strange and sad coincidence as belonging to the chapter of accidents, as due to the chances which always affect events depending on natural causes (as the weakening of embankments by frost and thaw, the action of winds, rain, snow-drifts, etc.), must we regard it as due to special intervention of Providence? Science tells us, and experience confirms her teaching, that in the game man plays (or his contest, if you will) with nature, the laws of nature are as laws of the Medes and Persians, that he must not expect to have his moves back, or any help outside the laws assigned (inexplicably so far as we are concerned) to nature; if he does expect this, he will most assuredly be disappointed.—*Knowledge.*

* I am perfectly aware that what was called carbonic acid gas twenty years ago now goes by another name; and I am equally aware that a technical meaning is given to the word "mixture" other than its ordinary significance. But I am not addressing chemists just now.

† For my own part I thought it exceedingly likely that before the lecture season came to an end, my lecturing might be interrupted. As week passed after week without an accident I neither judged that the next journey was more likely or that it was less likely to be disastrous. At last, toward the end of February, my turn came. The train I was in was pitched over an embankment, not far from Richmond, Missouri, falling some twenty or thirty feet and a stove drove its way through a stout plank within two inches of the place where my head lay. Was I lucky or unlucky? unlucky in going by that particular train; or, being in it, lucky in escaping with no injuries worse than a nearly fractured skull and a nearly broken leg. As I and the other passengers looked at the shattered interior of the car, we thought ourselves lucky to be alive; as we considered the various damages which our persons and property had sustained, we took a different view. (The accident turned out afterwards to have been singularly fortunate for me, but that is a detail.)

THE COLD SPRINGS AT LAKE ROTOMAHANA, NEW ZEALAND.

THE formation of the province of Auckland, New Zealand, is one of the most remarkable in the world, and it possesses not only an active volcano, but hot-spring mud volcanoes and running streams in which the warm springs break out at intervals. The principal place in which the springs are to be found is Lake Taupo, where baths have been erected, and which in time will be the great sanatorium of the Australian colonies. In the neighborhood of the proposed town of Rotorua there are a great number of these natural fountains, "from the boiling caldron of Orua Whata to the tepid springs of the lake shore; from the cold, sulphurous springs in the large reserve near the sanatorium to the scalding steam jets of Sulphur Point, which deposit the most beautiful crystals of pure sulphur in large quantities. Only a mile and a half distant from the center of the town a great geyser throws a column of boiling water forty feet into the air, while a smaller one is almost in constant action. The locality in which these extraordinary phenomena are to be seen in their greatest grandeur is at Lake Rotomahana, where the silicious deposits from the springs form gigantic white terraces rising to a height of about eighty feet. The water from the boiling spring above flows over these to the land below, filling in its course a large number of cisterns situated between the walls of the terraces. The water deposited in the cisterns is of the most exquisite turquoise blue, and is surrounded by a well defined rim of nearly snow-white rock. On the opposite side of the lake is a terrace of pink or salmon color, and all around there is a vast supply of active volcanic force. There are hundreds of fissures from which escape streams of boiling water and clouds of steam, sighing fountains, grunting fountains, fountains of mud, lucid fountains, fumaroles, and funnels lie within a few inches of the fragile crust below the traveler's foot." To any one in search of the wonderful and beautiful in nature a trip to these springs would amply repay the trouble and outlay. The most striking thing in connection with the most natural terraces in the vicinity of Lake Rotomahana, is the choice of temperature afforded bathers, each of the terraces containing hot or cold water, according to the circumstance whether the spring is running into it or has changed the position it formerly had, and allowed the water remaining in it to get cold. Visitors to New Zealand make a point of visiting these springs, and the beneficial effects of their use have been made abundantly apparent in the case of invalids.



THE COLD SPRINGS, WHITE TERRACE, ROTOMAHANA, N. Z.

There does not seem to be much the matter with the group in our sketch, who are evidently enjoying to the utmost the novel condition of being able to step from a hot to a cold bath at a moment's notice.—*Illust. Sydney News.*

ELECTRICAL PROGRESS AT THE CRYSTAL PALACE.

THE exhibition of electrical appliances at the Crystal Palace, London, is now assuming fair proportions, and is beginning to repay a visit. Although not quite complete yet, it is nearly so, and the majority of the electric lights are in their places. The absence of M. Gravier's lamps still constitutes a gap in the series of arc lights illuminating the nave; and Mr. Swan's incandescent globes are not yet fully installed, but there are Lane-Fox lamps now in the Alhambra Courts, and the British Electric Light Company have now suspended several elegant but rather feeble lamps in the Egyptian corridors. We refer more particularly to the incandescence system, because it is that in which the public interest chiefly centers, on account of its adaptability for domestic lighting. Taken as a whole the exhibition of incandescence lamps at the Crystal Palace is eminently calculated to display, to the best advantage, the merits of this new illuminant for lighting homes, not only in point of health and convenience but in point of decoration. The single bulbs hung by slender cords from the pointed roofs of the Alhambra, and inclosed in small racks of crystal drops, illustrate how well adapted the incandescent system is for hot countries and the rich colors of Oriental architecture; the globes burning under the water of the pond, and among the fern fronds of the tropical department, show how it may be turned to the illumination of aquaria, fountains, or foliage; and the bulbs of colored glass employed by Edison demonstrate how the tint of the light may be modified to harmonize with the furnishing of a room, the eyesight of an invalid, or the requirements of some chemical process.

The exhibit of Mr. Edison is complete now with the exception of the stalls and avenues leading to the high-level railway station; and the verdict on it is one of unqualified admiration. Never before has the electric incandescence light been seen to such advantage, thanks in great part to the floral designs of Messrs. Verity & Sons, of King Street, Covent Garden, who supply the fittings. The incandescence lamp lends itself to the fancy of the brass worker in a way that gas, oil, or candles cannot do; chiefly because there is no open flame requiring to burn in a particular position, giving off fumes which would smoke or tarnish gilding, and requiring more or less bulky supply pipes and holders. The electric bulb will glow in any position; it is fed by a slender wire, and does not tarnish the finest gilding. Messrs. Verity & Son have utilized these privileges to the utmost, and the chief result is a magnificent chandelier, which is suspended from the ceiling of the entertainment court and comprises ninety nine lamps. Some idea of its size may be gathered from the fact that it weighs nearly half a ton. In design it represents a large conical bouquet of flowers standing in a gilded basket. The stalks of the flowers are of hammered brass gilded, and each flower, in shape like a harebell or tulip, is of colored glass of various shades, red, blue, and green. In the center of each flower-bell is stuck an incandescent globe, and the effect of the rich gilding is to give a mellow splendor to the light. The lights can be lit up in zones or all together, according to the degree of illumination required.

There are other very elegant chandeliers in the entertainment court and in the concert-room, and also a fine collection of brackets; hall lanterns, drawing-room shade lamps, billiard lamps, and single or clustered bulbs either naked or under opal shades. The latter are intended to take the place of ordinary single gas-jets on stands and brackets; and one is shown which can be regulated in intensity by turning a switch and introducing carbon-resistance bars in circuit. Another application of the Edison lamp is its use in conjunction with mirror sconces for decorating rooms. The lamps are generally supported in front of the mirror; but in the case of one mirror the bulb is put inside the frame behind the silvered glass, and shines out through side panes of semi-transparent glass on the face of the observer.

Besides these illustrations of his lighting system, the entertainment court is filled with small tables containing specimens of Mr. Edison's various telegraphic inventions, similar to those displayed at Paris. No attempt, however, is made to show these instruments in operation, and therefore, they are of little interest to the general public.

The display of arc lights at the Crystal Palace is very fine, Messrs. Siemens exhibiting a very handsome chandelier of pendent globes, and Mr. Crompton, the Brush Electric Light Company, the British Electric Company (the Brockie lamp), Messrs. Strode & Co. (the Mackenzie lamp), and others, show some splendid lights. It would, however, be an improvement if a more concerted action existed among these exhibitors, so that a combined effect could be obtained. As it is they do not all light up at the same time, and thus some sections of the nave are dark while others are illuminated. When all the systems are in operation the rule should be that all should light up simultaneously and be simultaneously extinguished.

There is, however, a general want of method in the whole Crystal Palace Exhibition, and there are other symptoms of neglect. For example, the western gallery is filled with stalls containing many interesting objects; in fact, a great part of the exhibition is located there. Yet the western gallery is not properly lighted in the evening, and as a consequence, remains unvisited. Many people do not even know that there are any stalls there at all. What, it may be asked, is the use of inviting manufacturers and others to go to considerable expense to exhibit their apparatus there and not even supply sufficient light to see them by? It is obviously unfair to exhibitors to keep the western gallery and the eastern unlighted at night, and a very different course to that pursued by the management of the Electric Exhibition at Paris.

The Post Office collection is now complete, but we miss the operators who were to show the apparatus in action. The War Office exhibit, too, is installed, but it is very far from justifying the assertion of Professor Abel that we, as a nation, are even on a par with, far less ahead of, other nations in the arts of militant electricity. The most interesting objects are a set of Mance heliographs, a variety of submarine mines and torpedoes with their discharging apparatus, and a horse equipment for laying a field telegraph in mountainous regions.

As might have been expected, the display of apparatus illustrative of submarine telegraphy is very fair, owing to the important part played by England in this domain. Two of Sir William Thomson's siphon recorders are here shown in action, working on the duplex system through a Varley artificial cable belonging to the School of Telegraphy. There is also in connection with that school a very pretty experiment showing the retardation of a signal through a long submarine cable, by means of ten mirror galvanometers connected in circuit so as to show the progress of the signal through the line. The specimens of deep-sea bottom and other trophies, such as coral, shells, and sponges, brought up by the lead and submerged cables in repairing operations, are also very curious and instructive. Submarine telegraphy has done incalculable benefit to navigation in supplying accurate soundings to our charts; and the naturalist will also find a good deal to interest him in the samples of the Eastern Telegraph Company and the Eastern Extension Company. One specimen of cable picked up by the latter company in the East Indian seas is literally incrusted with corals so as to be quite invisible; and it is sometimes necessary to abandon cable submerged for a very short time because the coral insects have inseparably cemented it to the bottom. The teredo is also very common in these waters, and several specimens of this cable pest are shown. The length of these animals (from two to three inches) is surprising to those who have only seen the small Atlantic teredo; and one can readily understand how the Eastern Extension Company have recently found it necessary to cover the gutta percha core with a thin brass tape laid on without interlapping under the sheathing in order to stop their ravages. We may take this opportunity of referring to the very successful inauguration of the series of lectures which is to form a conspicuous attraction at the Crystal Palace during the next few months.—*Engineering.*

ELECTRICAL CONDUCTIVITY.

By HERBERT TOMLINSON, B.A.*

THE temporary alteration of electrical conductivity which can be produced by longitudinal traction was measured for all the metal wires used in Part I., both in the hard-drawn and annealed condition, and, in addition, for carbon and nickel.

The electrical resistances of all the substances which were examined were, with the exception of nickel, increased by temporary longitudinal stress. With nickel, however, of which metal a wire nearly chemically pure was at length with difficulty procured (through the kindness of Messrs. Johnson, Matthey & Co.), the resistance was found to *diminish* under longitudinal stress not carried beyond a certain point; but after this point had been attained, further stress began to increase the resistance. The effect on nickel appears still more remarkable when we reflect that the change of dimensions produced by the stress, namely, increase of length and diminution of section, would increase the resistance.

The *specific* resistances of all the substances, except nickel and aluminum, were increased by temporary longitudinal stress. With aluminum and nickel the specific resistances were *diminished* by stress not carried beyond a certain limit.

One of the most remarkable features discernible in the results is the similarity of the order of the metals to that of the order of "rotational coefficients" of metals recently given by Prof. Hall (*Nature*, vol. xxiv., p. 46; abstract of a note read by Prof. E. H. Hall at the meeting of the British Association at York); indeed so striking is the relationship in the case of the metals iron, zinc, aluminum, and nickel, that there would appear to be no doubt that a series of experiments made with a view of determining the effects of mechanical stress and strain on the "rotational coefficients" would be of the greatest value.

Another point to be noticed is that the alteration of the specific resistances of all the alloys, brass, platinum-silver, and German-silver, is much less than that of the several constituents of these alloys, and at first sight there would appear to be some relation between the alteration of resistance caused by change of temperature and that due to mechanical stress; but it has been proved by these and other experiments that the increase of resistance caused by rise of temperature is in some cases one hundred times that attending the same amount of expansion by mechanical stress, and, apart from the fact that with nickel and carbon the effects of change of temperature and of longitudinal stress are of an opposite nature, it is evident that the former are to be attributed to other causes than mere expansion.

Compression was proved to produce on the electrical resistance of carbon a contrary effect to that caused by extension; this statement applies to the alteration of specific resistance as well as of the total resistance.

Stress, applied in a direction transverse to that of the current, was also found to produce in several metals both temporary and permanent alterations of resistance of a nature opposite to those resulting from longitudinal traction.

Stress applied equally in all directions by means of a hydraulic press was proved to diminish the resistance of copper and iron; and the experiments showed that the lowering of the temperature of the freezing-point of water can be accurately and readily measured by observations of the change of electrical resistance of a wire.

The total resistance of most metals is permanently increased by permanent longitudinal extension, but with nickel the *total resistance* is permanently *decreased*, provided the extension does not exceed a certain limit; beyond this limit further extension causes the resistance to increase.

The small effects which can be produced by permanent extension, hammering, and torsion on specific electrical resistance were very fully investigated, and are shown in the paper by a series of curves. All the metals examined, except iron and nickel, have their specific resistances increased by strain caused by the above-mentioned processes, provided the strain does not exceed a certain limit, beyond this limit further strain decreases the specific resistance. In the case of iron and nickel, on the contrary, the specific resistance is at first *decreased* and afterward increased.

The effect on the resistance of annealed steel produced by heating and suddenly cooling was also studied, and it was proved that if the steel be heated to a temperature under "dull red," sudden cooling *decreases* the resistance; whereas if the metal be heated up to or beyond "dull red," sudden cooling *increases* the resistance; the strain, therefore, caused by this process, and that resulting from purely mechanical treatment, are similar as regards their influence on the electrical resistance.

The amount of recovery of electrical conductivity produced by time in wires, which are in a state of strain, is shown in the paper for several metals by a series of curves, and these exhibit most conclusively the superiority of platinum silver over German-silver when an accurate copy of a standard resistance has to be kept for a long period of time; in fact, of all the metals tested, German-silver showed the most marked recovery of conductivity, and platinum-silver the least.

The recovery of electrical conductivity is in all cases attended with recovery of longitudinal elasticity and of torsional rigidity.

A full examination of the influence of permanent strain on the susceptibility to temporary change of resistance from change of temperature showed that metals may be divided into two classes. In the first of these classes, which includes iron, zinc, and platinum-silver, the strained wire is *most increased in resistance* by rise of temperature up to a certain limit of strain, while beyond this limit further strain diminishes the first effect. In the second class, which comprises copper, silver, platinum, and German-silver, the strained wire is *least increased in resistance* by rise of temperature, but that here, again, after a certain point of strain has been reached, the first effect begins to be diminished.

After some trouble, means were found of measuring with considerable accuracy at 100°. C the alteration of electrical resistance due to temporary longitudinal traction, and the experiments led to the belief that the elasticity of iron and steel is not temporarily but *permanently* increased by raising the temperature to 100° C. Subsequently direct observations of the elasticity made in the manner described in Part I., but on shorter lengths of wire, placed in an air-chamber, the temperature of which could be maintained constantly at 100° C., proved beyond a doubt that if M. Wertheim, to whom we owe so much of our knowledge concerning elasticity, had examined the elasticity of iron and steel after these metals, tested at the higher temperature of 100° C., had again cooled down to the lower one, he would have found that what to him *appeared*, in the case of these metals (*Ann. de Chimie et de Phys.*, 3me série, 1844, p. 431) to be a *temporary* increase of elasticity was *really* a *permanent* one, and if the wires used had been tested several times, first at the higher and then at the lower temperature, he would have also found, *provided sufficient rest after cooling had been allowed*, that the elasticity of both iron and steel is *temporarily diminished* by raising the temperature to 100° C.

The temporary alteration of susceptibility to change of resistance from change of stress, which is effected in the case of nickel by raising the temperature to 100 C., is as remarkable as the susceptibility itself, and the maximum diminution of resistance which could be produced by stress when the metal was at the temperature of the room was actually *more than twice* that at 100° C.

The alteration of electrical conductivity which can be produced by magnetization was carefully studied, and a full account of the modes of experimenting, of the apparatus employed, and the precautions adopted will be found in the paper. The substances examined were iron, steel, nickel, cobalt, bismuth, copper, and zinc, and in all cases, except that of copper, it was proved that longitudinal magnetization increases the electrical resistance, whether the substance is in an annealed or unannealed condition.

Of all the metals examined, annealed nickel was by far the most affected by a given amount of magnetizing force.

The increase of resistance produced by magnetization can be very accurately represented by the formula $\gamma = a \cdot \frac{\alpha}{\alpha + b} \cdot \beta$; where γ is the increase of resistance, α the magnetizing force, β the induced magnetism, and a, b, constants for the same substance when the same amount of current per unit of area flows through the substance.

In the paper, curves are shown exhibiting the connections between increase of resistance, magnetization, and induced magnetism. From these curves, and from the fact of the above-mentioned formula holding good, it is assumed that the resistance will go on increasing with the magnetizing force even when the latter is so great that further increase of force does not produce perceptible increase of magnetism.

The "circular" magnetization which any magnetic substance undergoes when a current is conducted through it, seems to have very little or no appreciable effect on the electrical resistance of the substance, so that, if we compare the resistances of iron and platinum, the ratio of the two will be independent of the electro-motor employed in the "bridge."

The effects of temporary stress on the alteration by magnetism of the resistance of an iron or nickel wire are of a somewhat similar nature to those caused by the stress on the magnetic inductive capacity of these metals, and the same may be said with regard to the effect of the permanent strains due to extension, torsion, etc. Longitudinal stress, which may be made to diminish considerably the susceptibility to alteration of resistance from magnetization, cannot even when carried to the extent of causing breakage, change the *nature* of the alteration.

There is apparently a close relationship between the "viscosity of a metal and its specific electrical resistance, and it seems very probable that a full investigation of the former of these two physical properties by the method of torsional vibrations would afford valuable information respecting the latter.

* Communicated to the Royal Society by Prof. W. Grylls Adams, M.A., F.R.S.

WHAT ARE ELECTRIC CURRENTS?

PROFESSOR SYLVANUS THOMPSON, of Bristol, recently lectured at the Crystal Palace, London, on "Electric Currents: What are they?" This lecture, the first of a series which the directors of the Palace have organized in connection with the International Exhibition of Electricity, was delivered in the concert-room.

The lecturer began with an enumeration of the multifarious services now rendered to mankind by the electric current, such as the ringing of bells, the giving of signals, the transmission of messages by telegraph, and the giving of light. Yet, though its applications were endless, it was remarkable how little was known of its intimate nature. To understand the true nature of electric currents, or even of electricity itself, necessitated a wide range of study, the more careful because of the great variety in the different properties and phenomena. Electricity might remain in the form of "charges" on the surface of bodies, or might flow through their substance in continuous "currents." Yet it was not a material fluid, and the term "electric fluid" was now only used by those who knew nothing about modern investigations in the science. Nevertheless, a study of the various properties of electricity, the attractions and repulsions it set up, the sparks to which it gave rise, the chemical decompositions it effected, the magnetic actions it produced, all led toward a certain theory, only to be grasped when all these diverging lines were traced back to their logical origin. It was a matter of congratulation that so many eager and able scientific men were now devoting themselves to this youngest of the sciences, more especially as it was pre-eminently a British science. Almost every great discovery in electricity had been made by Englishmen. From the time of Dr. Gilbert, who founded the science in 1600, Englishmen had been foremost in electric discovery. Boyle, Hawksbee,

Sir Isaac Newton, were among the foremost investigators. Stephen Grey discovered that electricity could be made to flow in currents through wires; John Canton discovered the influence exerted by electricity at a distance; Benjamin Franklin, the inventor of the lightning rod, was a Briton, though resident then in Philadelphia; Humphry Davy, the discoverer of the electric light; Spencer, the inventor of electro-plating; Faraday, the greatest experimentalist in electric science that ever lived, to whose fundamental discoveries modern dynamo-electric machinery may be directly traced; Ronalds, Cooke, and Wheatstone, the fathers of the electric telegraph, and Swan, the inventor of the carbon-filament lamp, were all Englishmen, while Graham Bell, the perfecter of the telephone, was Briton-born. Not that some great discoveries had not come from other lands. Cunæus, a Dutchman, discovered the Leyden jar; Volta, an Italian, discovered the Voltaic cell; Oersted, a Dane, discovered the relation between magnets and electric currents; Reis, a German, invented the first rude telephone by which articulate speech was transmitted; and Planté, a Frenchman, invented the storage-battery or accumulator. Professor Thompson describes the production of electricity by means of friction, showing the action not only of frictional machines, but of machines on the inductive principle. He pointed out the gradual development of voltaic electricity, from Volta's pile to Daniell's, Grove's and Bunsen's cells, at the same time directing attention to the costly method of producing the current by the consumption of zinc. As an illustration he explained the theoretic work obtained by the consumption of 1 oz. of various kinds of fuel, thus:

1 oz. of coal gives	695,000	foot-pounds.
" gunpowder gives...	100,000	" "
" zinc gives.....	113,000	" "
" copper gives.....	69,000	" "
" hydrogen gives.....	2,925,000	" "

After thus referring to the relation between the power of electric currents and the power that is spent in producing them, Professor Thompson spoke of the certainty that in the near future all heavy mechanical work would be done by electric currents in the place of steam, a theme which will claim further attention in a subsequent lecture. Developing the question of the production of electric currents in voltaic batteries, the lecturer referred to the discovery that such batteries were reversible, and that in this reversibility lay the newly-discovered power of storing or accumulating electric energy in cells which could be charged and discharged at pleasure. The magnetic and thermal properties of the electric current were illustrated experimentally, the lecturer remarking, with much emphasis, about the physiological properties that the mistake of confounding these with medical or remedial effects led to the gross impositions of the quacks and rogues who deal in so-called magnetic appliances, and disgrace alike the sciences of electricity and of medicine, while knowing nothing of either. The nature of electric currents was reverted to, and an outline was given of the theory of Clerk Maxwell that all electric phenomena were due to actions going on in the thin medium that fills the whole universe—the *ether*—vibrations of which are light and heat, the accumulations of which are electric charges, the streams in which are electric currents, and which, where it was made to spin round in vortices or whirlpools, gave rise to magnetic attractions. In conclusion, the lecturer commented on the immense importance of the revolution now beginning in the substitution of electric machinery for steam engines, and urged that if England desired to reap the benefit of this impending reorganization of the methods of mechanical production, if she desired that her workmen should rise to the immense future before them, she must not lose an hour in providing them with an education in matters electrical, seeing that a knowledge of electric currents and their properties will be of far more practical importance than a knowledge of any other branch of science. If technical education did not come in any other way, it would be forced upon us by the practical fact that electricity is to be our servant in the place of steam and of coal.

THE SEDLACZEK ELECTRIC LOCOMOTIVE LAMP.

THIS lamp has given such satisfaction on the Crown Prince Rudolph Railroad (Austria), that the French Northern was induced to experiment with it, and finally to adopt it. The experiments were made in Paris under the supervision of Civil Engineer Banderali.

We shall first describe the apparatus. The lamp is formed of two vertical communicating pipes of unequal diameter, as may be easily seen from the diagrammatic section of the apparatus, Fig. 1. The two carbons are fixed to the piston-

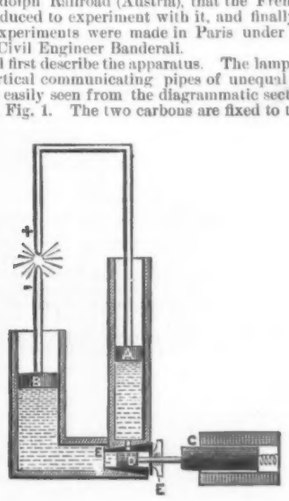


FIG. 1.

rods of the two pistons, A and B, which move in two cylinders communicating at their bottoms so as to form a kind of siphon. The cylinders are filled with oil or glycerine, and their diameters are in the proportion of 1 to 2 where continuous-current machines are employed, the larger piston carrying the negative and the smaller the carbon, but the lamp can also be modified for alternating currents when the pistons would be of the same size. The positive piston, A, is made heavier per square inch than the other piston, so that when the two cylinders are in communication with each other, the piston, A, depresses the liquid and raises the piston, B, till the carbon points are in contact. A cock, E, is bored up the center, and has also a small lateral perforation, corresponding with a similar small hole in the bottom of the smaller cylinder. Inside the cock is a small movable piston, D, also perforated with a fine angular passage. When the openings in the piston, D, and the cock, E, coincide, the two cylinders are in communication, and the liquid can pass from the small to the large cylinder. The piston, D, is connected to an iron core, C, which can move freely inside the wire bobbin surrounding it, and is pressed outward by a spiral spring. The wire bobbin or coil forms part of the electric circuit. Before starting the current, cock, E, is opened, and the cylinders brought into communication when the two carbons will be brought into contact. When the current is started the core,

FIG. 2.

E, is drawn into the bobbin, and the piston, D, pulled outward. The communication between the cylinders is thereby interrupted, and by the outward movement of the piston, D, the liquid inclosed between it and the piston, B, is drawn into the cock, E, consequently the piston, B, sinks while the piston, A, remains fixed, and the carbons become separated. The distance at which the carbons remain apart can be regulated by adjusting the spring, pressing the piston, D, inwards, according to the strength of the current. The arc light is thus produced, and as the carbons burn off the current becomes weaker, and the spring forces the core, C, out and piston, D, inward, thereby raising the piston, B, and approaching the carbons to each other. When the carbons have been so much consumed that the opening in the piston, D, comes opposite the perforation of the cock, E, a drop of liquid passes from the small into a large cylinder, carbons are brought closer together, and the current increas-

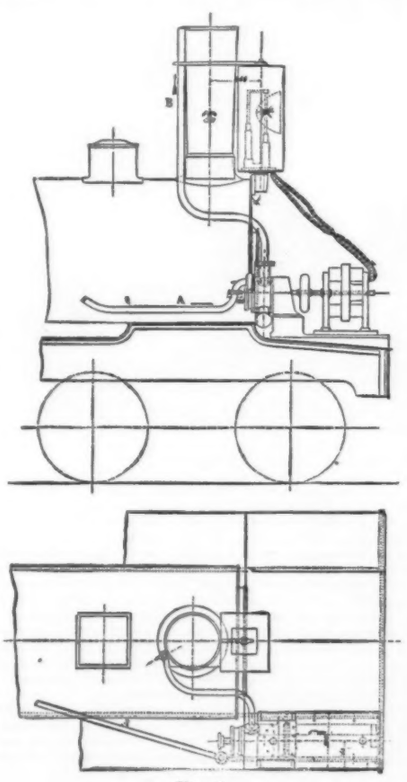


FIG. 3.

ing in strength, the piston, D, is drawn outward again and the communication between the cylinders interrupted. In this manner the intensity of the light is said to remain as in the best kinds of other arc lamps, the liquid passing drop by drop from one cylinder into the other. As the large cylinder has double the area of the small one, the movement of the positive carbon is double that of the negative one corresponding to their respective consumption with continuous currents, while the position of the arc remains the same till the carbons are consumed. For the insertion of new carbons, the cylinders are placed into communication, and the liquid forced back into the small cylinder by pushing the piston, B, down.

While Fig. 1 is a diagram of the lamp, Fig. 2 gives its perspective, and Fig. 3 an explanation of the actual arrangement of the apparatus. The electric current is produced by means of a Schukert induction machine, with continuous current, and is fixed to the shaft of a Brotherhood motor with three cylinders. The normal speed of the machine is 700 revolutions a minute. The steam feed is obtained direct from the boiler through the pipe, A (Fig. 3), while the waste steam escapes by the pipe, B. No data are given as to the labor required in producing the steam.

We will now relate the experiments made on the portion of the Northern railroad lying between Paris and Dammartin. The dynamo-electric machine and the motor were fastened on the platform of an express locomotive, as may be seen from Fig. 3. The lamp and the reflector were placed in a case immediately in front of the chimney and at a distance of about 10 feet 9 inches above the rails. The lamp was set "agoing" immediately on leaving Paris, and it worked without any hinderance till it arrived in Dammartin. The illumination was somewhat as follows: The illumination in the immediate neighborhood of the locomotive and for a distance of 26 yards was very intense, so that it was possible to distinguish clearly all the details of the rail bed and the inequalities of the ground. From thence to a distance of about 160 yards the light was such that the entire road and rail bed could be distinguished easily. The extent of vision was from 270 to 325 yards. It was also observed at both stations that the electric light had no unfavorable influence in distinguishing the colors of the different signal lights—they remained absolutely unchanged. The reflector was placed in a better position on the occasion of the second experiment, and the results were much more satisfactory, objects being seen to a distance of 530 yards, and some edifices to even 650 yards. The speed was about 40 miles an hour. The switchmen found no difficulty in making out the position of the switches at a considerable distance. The light cone was visible to a distance of five kilometers. The employes of trains coming in opposite directions found no inconvenience from the light, except when they looked fixedly at it for a prolonged time.

NOTES ON LEAD PIPES AND LEAD CONTAMINATION.*

By WILLIAM THOMSON, F.R.S.E.

THE question of the contamination of water by lead pipes having been recently revived by Dr. Sedgwick Saunders' translation of M. Belgrand's brochure, made in accordance with the instructions of the Commissioners of Sewers of the City of London, I propose to bring before the society a few notes on the same subject, which may be of interest.

About three years ago I examined a sample of water to ascertain whether it contained any objectionable ingredients, and found it to be contaminated with lead to the extent of 0·197 grain per gallon. The composition of this water was as follows:

	Grains per Gallon.
Total solid matter.....	7·971
Organic matter, combined water, etc.....	1·817
Saline matter.....	6·154
The saline matter was composed of:	
Chlorides of sodium and magnesium.....	1·543
Sulphates of soda and magnesia.....	1·146
Sulphate of lime	2·328
Carbonates of lime and magnesia, and oxide of iron.....	1·137
	6·154
Free ammonia.....	0·0028
Albuminoid ammonia	0·0085
Oxygen contained in potassium permanganate required to oxidize organic matters, etc., acting in the cold during three hours,	0·028
Nitrates and nitrites	absent.
Total hardness.....	3·8°

I advised that this water should not be used for drinking purposes on account of the lead which it contained, and I afterwards learned that one of the members of the family, being ill and under medical treatment, suspected that there might be something wrong with the water in question, because she was better in health when away from her home, and it was only after lead had been detected in the water that lead poisoning was even suspected by the medical attendant, and it then became evident that the patient was suffering severely from lead poisoning, all the symptoms being strongly marked. The gums were tinged with a bluish shade and the fingers of both hands had become stiff and partially paralyzed.

The interesting points connected with this case are that while a number of persons were using this water, only one suffered severely from lead poisoning, although others of the family were in indifferent health previous to, and enjoyed good health after, the removal of the lead pipe which conveyed the water from the well to the house. As this lead pipe, which was in all probability the cause of all the unhealthiness of the family, had been in use for twenty-one years, it would have been interesting to have known the condition of health of the previous occupants of the same house, and if not satisfactory to have learned whether or not any medical man diagnosed any of the cases as those of lead poisoning, as there seems little doubt that those who lived in this house must have suffered, more or less, from this cause. It seems, unfortunately, probable that many persons may be suffering from slow lead poisoning without the real nature of the malady being recognized by medical men, as it was in the case of the lady above mentioned, who, by philosophical reasoning and experiment, solved the problem which puzzled the doctor.

The house referred to was supplied from a well about five hundred yards distant, the water passing by gravitation through a one-inch lead pipe, and although this pipe had been in use for twenty-one years, and the water which passed through it contained certain proportions of sulphate and carbonate of lime, yet the pipe had not become coated, as M. Belgrand says is the case with the lead pipe in Paris, and as is generally supposed to be the case, but was, according to the description of the owner of the house, as free from inside coating when taken out as it was when put in.

I was asked to suggest a substitute for the lead pipe, and advised the use of tin-lined lead pipe where the coating was about one-sixteenth to one-twentieth of an inch thick, because some samples which I had obtained and examined several years before did not in the slightest degree contaminate water when

* Read before the Manchester Literary and Philosophical Society.

kept in the pipe for many days. My suggestions were carried out, and a sample of the water which had passed through this tin-lined pipe sent to me for examination. I found it to be contaminated with lead to a considerable extent, and on examining some of the tin lining, I found it to contain a large proportion of lead. I sent to another manufacturer of this tin lined pipe for a sample. This he sent me, and again I found that the tin lining contained a large proportion of lead, and quickly contaminated water left in contact with it. This I communicated to the manufacturer, who informed me that he could not understand how the tin lining had become contaminated, unless it was by its being poured down the side of a strip of lead into the hole left in the solidified lead in the cylinder previous to forcing it through the dies by hydraulic pressure. As I understand, this pipe is produced by pouring melted lead into a cylinder, through the top of which an iron shape is introduced to make a cavity in the lead of sufficient size to hold the necessary quantity of tin; the lead is then allowed to set; when this occurs the iron shape is withdrawn and molten tin poured in to fill the space which the iron shape previously occupied; a "die" composed of an iron tube with a core dips into the tin, which remains liquid in the cavity, while this outer tube forms the core of another tube through which lead is forced, the innermost core being prolonged, so that the tin comes in contact with and solidifies on the interior of the lead pipe. It seemed to me remarkable that a manufacturer who was cognizant of the fact that tin dissolved lead should have allowed such a device as the pouring of the tin down a strip of lead to be employed for filling the mould.

These tin-lined lead pipes, I understand, are used to a large extent, and principally in making communication between the beer in the cask and the pump on the counters of beer retailers. Such pipes would give the idea of safety, but it is clear that many samples of it may be of such a nature as to contaminate beer with lead to a large extent, as the beer contains a certain amount of free acid which would in all probability be capable of dissolving the lead; and one would expect that the person who consumes the first glass of beer from the pump in the morning would get that which had remained over night in the pipe, and would imbibe, therefore, a considerable quantity, depending on the quality of tin lining, of the poisonous metal.

To test whether this was really the case, a few days ago I got two samples of beer, drawn in the morning, from two pumps at the same place, and examined them, and found a considerable proportion of lead to be present in each. To find whether it was possible to obtain tin-lined lead pipe, in which the tin was free from lead, for making communication between the house and well above mentioned, I obtained a number of samples of this variety of pipe from the same and from different manufacturers, and tested the purity of the tin lining inside each, but failed to find one which was not contaminated with lead, and which did not contaminate water when left in contact with it for two or three days, to a greater or lesser extent; one or two samples, however, contained very little lead, and only caused a minute trace of contamination in the water, but the majority contained a large percentage of lead, and polluted the water to a great extent. Ultimately, the gentleman who occupied the house referred to had the tin-lined lead pipe which replaced the lead one dug up, and communication with the well established by five hundred yards of block-tin pipe; and since this change was made, he informed me lately that his family have enjoyed good health.

There is another kind of lead pipe manufactured called "tinned lead pipe," the inside of which is covered with a very thin coating of a white metal to afford protection against the action of water on lead; as a matter of fact, this coating is not tin at all. It is produced by filling the first few inches of the ordinary lead pipe which is forced through the dies, while still very hot, with molten tin, which remains molten and washes the inner surface of the lead tube as it is produced. Presumably, when a long length of pipe has been forced through the dies, there would be little or no tin remaining, but I was informed by a manufacturer of this pipe that that is not the case; on the contrary, there is a much larger volume of tin, to use his own language, at the end of the operation than there was at the beginning; the molten tin dissolves the lead, thus increasing in volume, and so the coating is a mixture of lead and tin, the proportion of lead in the coating being greater in those portions of the pipe which are last forced through the die.

Some years ago, not knowing of the existence of this kind of tinned lead pipe, I requested a plumber to make for me a worm refrigerator with tin lined lead pipe for the preparation of distilled water. He did so, and to my astonishment, on testing the distilled water which had been condensed in it, I found it to contain a large proportion of lead. On examination of the pipe afterward I found it to be the variety which had been washed with tin. This coating cannot therefore be regarded as a thoroughly efficient protection against the action of water on lead; but the test was a severe one, and there can be no doubt that tin-coated lead pipe is much better adapted for use in making communication with the water mains in large towns than the ordinary lead pipe, while the cost of producing this coating, I understand, amounts to only a few shillings per ton of pipe. To test their respective values, I placed water containing a small proportion of nitrate of ammonia in two pipes of the same sizes, the one tinned inside, the other the ordinary lead pipe. After standing about three hours I tested the water from each; the one from the tinned lead pipe contained only a trace of lead, while that from the ordinary lead pipe contained a large proportion of lead in solution. Similar results were obtained by leaving Manchester water in the same pipes for eighteen hours.

In certain boroughs, I understand, such as Salford, Oldham, and Southport, this tinned lead pipe is the only kind allowed to be used for making communication with the main, while in Manchester and other places ordinary lead pipe is generally employed. I have lately observed that the lead pipes which have been in use in Manchester for many years contaminate water left in them over the night to a considerable extent, but after the water has been used for a short time during the day, it is free from any appreciable trace of lead.

I have also tested the water after remaining eighteen hours in the lead pipes in communication with the main in Salford, where the tinned pipes are employed, and although the water was slightly contaminated with lead, it contained much less than that found in the water which stood for the same length of time in the ordinary lead pipes of Manchester.

It is a fact which I have observed from my experience during the last few years, that aerated waters are contaminated with lead much more often, and in many cases to a much greater extent, than one would expect, considering the attention and care which is bestowed by good firms on the manufacture of these articles. Lately I tested several samples of what was termed "pure" carbonate of potash, and "pure" carbonate of soda, and citric acid, which were specially purified for use in the preparation of aerated waters, and I found all to be contaminated with lead to a greater or less extent. The manufacturer of these samples was apprised of this fact, and in reply he admitted that they contained traces of lead, but said it was impossible to obtain these substances free from metallic contamination at anything like reasonable cost, and he was quite satisfied that the quantity was not objectionably large. To overcome this difficulty I had to advise the use of the ordinary carbonate of soda, made by Solvay's ammonia process, as being almost as pure, and certainly much less likely to be injurious, than the purified salt. I also advised that those salts which it is impossible to obtain free from lead should be dissolved in water, and filtered through or boiled with animal charcoal, which has the property of removing the lead from solution. It might here be noted that the use of charcoal filters diminishes very much the risk of lead-poisoning, as the charcoal removes any trace of lead which the water might contain.

It was first discovered and afterward published by the late Dr. Crace-Calvert and Mr. Richard Johnson in a joint paper, that pure lead is more easily acted on by sulphuric acid than lead containing a very small percentage of impurities such as antimony and copper, and these results have been repeatedly verified since. With a view to find the effect of pure water on comparatively pure lead and on lead to which I added three-quarters of a per cent. of antimony, I melted some of the original lead and poured some out, which I rolled into a sheet. Antimony was added to the remainder, and the mixture poured out and rolled into a sheet as before; both sheets were cut to the same size and placed in equal bulks of distilled water and left over night. In each case a fine white flocculent crystalline matter, an oxide or salt of lead, was observed in suspension, but this existed in considerably greater proportions in the water containing the lead which had not been treated with antimony. Thus the small quantity of antimony appears to afford some protection against oxidation of the lead by air and water. When the suspended matter was filtered off only a trace of the lead was found to be in solution in each case.

It is sometimes advisable to obtain the lead contained in water in a contracted solution, and preferably in an acetic acid solution if possible. I have observed frequently that weak acetic acid dissolves no lead from the residue left on evaporating waters which gave originally a very distinct coloration with sulphureted hydrogen, but, on treating the residue with strong nitric acid, evaporating off the acid completely and again treating the residue with weak acetic acid, the lead dissolves with apparent facility, and on evaporating this acetic solution of the metal to a drop or two, it may be obtained in a sufficiently concentrated solution for the application of the other tests. It appears as if certain organic matters contained in the water combine with and render the lead insoluble in acetic acid; these organic substances being afterward decomposed by the nitric acid, leave the lead in a condition in which it is soluble in acetic.

A curious case of lead poisoning lately came under my notice and engaged the attention of a Lancashire coroner. A woman upon whose body the inquest was held, had been employed in weaving cloth from yarn which had been dyed of a yellow color. The color was the ordinary chromate of lead, and it was alleged that the dye had caused her death by poisoning.

I examined some of this yarn, which I found to be of an orange-yellow color, due to the chromate of lead which had been fixed in the fiber, but it was so loosely fixed that by gently shaking a hank the chromate came out forming a cloud of yellow dust, and it was given in evidence at the coroner's court that all or nearly all the workpeople who had been engaged in weaving this cloth suffered more or less from lead poisoning.

I afterward examined some yarns containing the same pigment color fixed in the thread so firmly that it could not be removed by shaking.

PRESERVATION OF WOOD.

DR. JOSEPH JONES, of New Orleans, has, after an extended series of experiments, inaugurated eighteen years ago, in 1864, succeeded in developing a method of preserving wood from decay for great periods of time, and even for centuries. The first series of experiments related to the preservation of animal structures; and in the museum of the medical department of the University of Louisiana are preserved in the open air the most delicate and destructible animal tissues, and entire animals, apparently as fresh as at the moment of death.

The second series of experiments related to the arrest of decomposition in diseased and gangrenous ulcers, cancers, and gunshot wounds, and the results were none the less striking and satisfactory.

The third series of experiments related to the preservation of wood from decay and the destructive action of marine animals.

The process, as finally developed and perfected by Prof. Jones, consists in saturating wood with certain bituminous, resinous, and antiseptic substances and compounds. The sap and moisture of the wood are transformed into steam, and the albuminous constituents coagulated by heat, and the wood thus treated is immediately plunged into a boiling solution, the most important ingredients of which are asphalt or solid bitumen and carbolic acid. The combination may be varied according to the age and density of the wood. As the preservative liquid and wood cools the vapor is condensed and the solution of asphalt is driven into the pores and also penetrates the wood by imbibition. The solvent of the asphalt rapidly evaporates from the surface of the wood after it is removed from the preservative fluid, leaving a smooth, polished surface, impervious to moisture and water. The antiseptic substances are thus locked up within the fibers of the wood. Thus, if it be desired to subject a railroad bridge to this process, the individual portions after they have been completed, are first heated, in order to drive out all the moisture, and then plunged into the solution of asphalt; and after remaining from two to twelve hours, are removed, and each individual part is protected by a complete coating of asphalt, impervious to water, and itself one of the most powerful of wood preservers. When the bridge is erected every portion of it presents a coated surface, and the whole structure presents the appearance of having been carefully painted by hand with durable black varnish.

The saving of expense alone in this mode of painting an entire bridge simply by plunging its component parts into a preservative fluid, it is claimed, will more than equal the expense of the materials used. Wood may be subjected to the hot solution of asphalt without preliminary heating.

A drying room for the wood and a tank heated by steam for the preservative liquid are the only forms of apparatus needed. Solid bitumen or asphalt is found in most countries of the globe; but it is to the West Indies that the United States must look for inexhaustible supplies.—*New Orleans Democrat.*

HYGROMETER FOR MILLS.

MOISTURE in the atmosphere is produced in two ways, which, however, are only different degrees of the same mode—by the ebullition of water contained in a vessel, in which case the water, in the shape of steam, bubbles through the body of the water and passes visibly into the air; or by slow evaporation, under ordinary atmospheric conditions, in which the vapor rises invisibly from the surface of the water only. It is this latter which generally affects the atmosphere, and is what concerns us at present. The amount of moisture which the air inclosed in a stated space can carry is, at a certain temperature and barometric pressure, a fixed item. When this has been attained evaporation ceases, because the counterpressure exerted by the vapor upon the surface of the water prevents more vapor from rising. The air is then in a state of saturation. When the temperature is, however, raised, evaporation commences again until its point of saturation has been reached; on the contrary, when the temperature is lowered, the moisture is condensed, and falls in the shape of dew until the superfluous amount of water has been removed. We thus see that the point of saturation depends upon and varies, for one thing, with the temperature. Air is called damp when it approaches its point of saturation, and dry when its condition is far removed from it. When air is damp and its degree of temperature is lowered, the moisture condenses as dew, and it becomes perceptibly wet; when, however, air which we call dry is cooled, it will require a considerable lowering of the temperature before it begins to deposit part of its moisture. Experiments by physicists have determined the maximum of moisture which air can contain at stated degrees of temperature under the ordinary state of the barometer, as, for instance, at a temperature of about 50° F., or 10° C, only 9·2 grammes, or 138 grains, per cubic meter, or 36 cubic feet.* The air is then saturated, and the slightest reduction of temperature deposits dew. This occurs, however, seldom in nature. Thus in summer, in hilly districts, 11·36 grammes is the average, while at the usual temperature as much as 15·1 grammes could be carried. 11·36 is 75 per cent. of 15·07. Thus the air then holds 75 per cent. of the possible amount of saturation. This figure, which shows the actual part of the amount

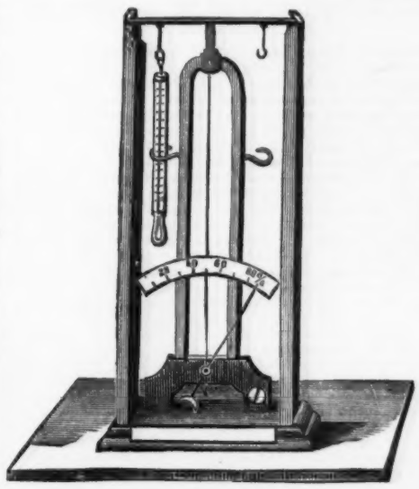


FIG. 1.

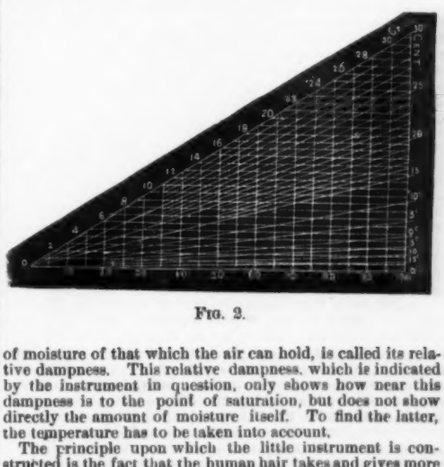


FIG. 2.

of moisture of that which the air can hold, is called its relative dampness. This relative dampness, which is indicated by the instrument in question, only shows how near this dampness is to the point of saturation, but does not show directly the amount of moisture itself. To find the latter, the temperature has to be taken into account.

The principle upon which the little instrument is constructed is the fact that the human hair takes and gives more readily than any other substance the moisture in the air and alters its length accordingly. There is, therefore, a strong hair, attached to an upper screw, and wound below round the pivot of a finger which indicates the degrees. Any lengthening of the hair by moisture and shortening through drying will thus be accurately recorded. Similar instruments have had the drawback that they get soon out of order. The present one has, however, a very easy adjustment for testing and setting it, and is claimed, on that account, specially adapted for mills. In a drawer below the finger there is a small frame covered by fine muslin; before commencing operations this muslin is well wetted and the water allowed

* We give these values in French equivalents because the diagram to which we shall refer is made out for these scales, which are easily reducible when required for English values.

to evaporate and ascend, when the hair will be lengthened. The finger will then point to 100. If it does not do so it is only necessary to turn the upper screw by means of a key until it does. A few minutes later the instrument will be ready for use. Having thus found the relative moisture in the room, and observed the temperature on the thermometer, it is only necessary to refer to the subjoined diagram to ascertain the absolute dampness. Thus, for instance, if the finger points to 70 and the thermometer stands at 20, we find the intersecting point of the corresponding vertical and diagonal lines; thence following the horizontal line to the left until we arrive at the figure 14, which indicates the amount of moisture in grammes in one cubic meter of air. Following the horizontal line to the right we come to the figure 14, or the point of saturation for that temperature; or, in other words, the air can be cooled 6 degrees, from 20 to 14, before dew will appear. This latter point is of the utmost importance for mills, for by a careful observation with this instrument the temperature in the room can be so regulated that it contains more or less moisture without the latter being deposited as dew upon the machinery or being in any way disagreeable or injurious to the hands, while without such an instrument a manager may not get near enough dampness for his yarn and still have too much for the lungs of his workpeople.—*Textile Manufacturer.*

THE TRANSFORMATIONS OF BACTERIA.—NEW THEORY.

A SERIES of experiments, which have been carried on at Wurzburg by Dr. Rosenberger, seem to involve important modifications in the views at present current regarding the development of septicæmia and of the organisms to which it is in apparent relation. It has already been found that a septicæmic virus, which has been exposed to a temperature sufficient to destroy all the bacteria it contains, will still cause the death of an animal into which it is injected. It is currently assumed that the animal is poisoned, not infected—*i. e.*, that the virus causes death by its presence, not by its multiplication, and that a second animal cannot be killed by the injection of a small quantity of the blood or serum of the first, any more than in a parallel case of strychnine poisoning. To decide this question, septic blood and serum were heated filtered, evaporated, and then injected. The animals died with all the symptoms and pathological appearances of septicæmia, just as if the uncooked virus had been used. Moreover, it was found that the blood-serum of the tissues and cavities contained the same micro-organisms and in the same quantity as animals into which the uncooked virus had been injected. The effect of heat was, however, to lessen greatly the virulence of the poison, so that a cubic centimeter was needed of a virus of which before the minutest quantity sufficed. Further experiments showed that septicæmia could be produced in other animals by the injection of even extremely small quantities of the blood, or tissue serum of those that had been killed by the inoculation with the cooked virus, which appeared thus to have acquired by renewed development the intensity of which it had been deprived by heat.

An obvious objection to the experiments of Rosenberger is that the heat employed may have been insufficient in degree or in duration, and that some of the specific micro-organisms may have escaped its action. To meet this objection he exposed the virus to a temperature of 140° C. for two hours, and made the inoculation with a perfectly new syringe washed with carbolic acid and absolute alcohol, but obtained the same result. The fact that the virus was effectually sterilized, so far as organisms are concerned, was ascertained in each experiment by the addition of some of the virus to some extract of meat, which remained for weeks perfectly clear and free from organisms.

With Koch and others, Rosenberger distinguishes two forms of septicæmia in the guinea-pig, similar in clinical symptoms and coarse pathological appearances, but differing in the form of bacteria to be found in the blood. The first form, known as "Pasteur's septicæmia" or as "malignant œdema," may be readily produced by the injection of some peritoneal fluid from an animal in which peritonitis has been produced by the introduction of a fragment of decomposing muscle into the abdominal cavity. In this form no organisms are found in the blood, or merely a few micrococci, while in the fluid of the œdema which forms around the place of inoculation there is to be found an immense quantity of large and small rod-shaped bacteria, and of micrococci. The second form, "Davaine's septicæmia," may be produced by the injection of blood which has been undergoing decomposition for about ten days. The blood in this form contains small biscuit-shaped micro-organisms which are always absent in the other form, and, *a fortiori*, in normal animals. Rosenberger has succeeded in producing both these forms of septicæmia by the injection of the cooked virus, and with the result that the blood of the affected animal contained in each case the same organisms which were present in the virus before it was exposed to the action of heat. In the animal killed by the injection of the cooked poison of malignant œdema, the serum of the œdema near the seat of the inoculation showed the clear refracting rods and micrococci, although there were no organisms in the blood. In the other form rod-shaped and biscuit-shaped bacteria were found near the place of injection, but, in the blood, only the latter form. The organisms rapidly multiplied in culture liquids to which a drop of the serum or of blood had been added, and those liquids injected into other animals caused rapidly fatal septicæmia.

The inference from these experiments is that the application of a degree of heat which apparently sterilizes effectually a septicæmic virus, so far as artificial cultivation of the organisms is concerned, does not prevent the virus from producing in the animal body its specific form of septicæmia and of septic bacteria. From these facts the startling conclusion is drawn that the bacteria are not primary but secondary elements in the morbid process, and that their development is associated with a chemical or at least unorganized poison. It is not asserted that the bacteria are without influence on the morbid process; on the contrary, Rosenberger believes that they alone are the means of multiplying the poison in the animal body, and in a culture fluid inoculated with the cooked virus and kept at a suitable temperature there is not only no growth of organisms, but also no increase of virus. If two similar culture fluids are inoculated, one with the cooked virus and the other with some blood of an animal which has been killed by injection of cooked virus, the former remains unchanged, and injected into an animal is without effect, while the other becomes opaque in the course of a few hours, and has developed powerful septic properties.

The development of the specific bacteria after the injection of the sterilized virus is explicable, Rosenberger believes, only on the assumption that they arise from non-specific bacteria previously present in the body, since, according to his facts, they arise independently of the introduction into the system of other organisms or other germs. This it is needless to point out, is a conclusion scarcely less than revolutionary as regards certain theories of the origin of the specific organisms of disease. It is not, however, altogether unsupported by previous experiments. A year ago, Buchner published observations which seemed to show that the bacillus of anthrax might be developed from a non-specific fungus found in hay. His experiments were not, however, altogether conclusive; he obtained by the culture of the anthrax bacillus an organism which, in the fifteen hundredth generation, was identical in characters with one obtained by the artificial cultivation of the hay fungus, but he failed to obtain, by injection of the latter, the specific disease which was produced by the former. Important and suggestive as are the experiments of Rosenberger, the conclusions which he draws from them are so much opposed to those of most previous experiments, that to many persons the most probable explanation will doubtless be the assumption that some germs must have resisted the action of heat, and have survived in a condition to develop in the favorable soil of a living organism, although not in a mere culture liquid. At the same time it must not be forgotten that septicæmia belongs to a class of diseases of low specificity, like typhoid fever, diphtheria, and erysipelas, the occasional origin of which by the transformation of a non specific virus is highly probable. In connection with his theory of the development of septic bacteria from non-specific virus some observations which have just been published by Rossbach also deserve mention. The latter has pointed out how constantly organisms in small numbers are present in the healthy blood, which appears to constitute a soil unsuited to their more considerable development. They may be demonstrated by the excision of parts of the body, and the immediate preservation of these in melted paraffin, or by the examination of the blood of the heart immediately after death. Larger quantities of organisms are almost universally assumed to have entered from without. But Rossbach, in experiments on the physiological action of papayotin, has found that an hour or two after the injection of a solution of this substance into a vein, the blood contains enormous quantities of micrococci, and even of round and biscuit-shaped bacteria, in lively movement, and responding to all the characteristic tests. Here, then, we have a case in which the blood of a perfectly healthy organism is so altered by the presence of a chemical ferment of vegetable origin and free from organisms, that the bacteria present in the normal blood increase with such marvelous rapidity that the state of the blood is comparable to that which results from a true infection. These facts thus suggest the same conclusion as do those of Rosenberger, and his theory derives from them considerable support.—*Lancet.*

ROYAL ASTRONOMICAL SOCIETY.

THE annual general meeting of the society was held at Burlington House, London, February 10; J. R. Hind, Esq., President, in the chair. During the year the following papers have been published in the Memoirs of the Society: Mr. David Gill, "Account of a Determination of the Solar Parallax from Observations of Mars, made at Ascension in 1877;" Mr. Common, "Particulars of the Mounting of a Three Foot Reflector;" Mr. Seabroke, "Catalogue of Micrometrical Measurements of Double Stars;" and Mr. Ranyard, "Observations of the Total Solar Eclipse of 1878, July 29, made at Cherry Creek Camp, near Denver, Col." Among the associates of the society, Prof. Carl Bruhns and M. Alfred Gautier have died during the past year. From the reports of observatories, it appeared that at Greenwich observations have been made with a half-prism spectroscope of the spectra of sun-spots, which have been observed on twenty-four days. The displacement of the F or *b* line has been measured in the spectra of sixty-four stars, nine of which have not previously been observed. Photographs of the sun have been taken on 173 days; these have been measured in duplicate, and the heliographic latitudes and longitudes of the spots have been deduced. At Mr. Huggins' observatory a photograph was secured of the more refrangible portions of the spectrum of Comet *b*; the head of the comet was brought upon the slit, and afterward through the other half of the slit a spectrum of *Arcturus* was taken for the purpose of comparison. The continuous spectrum could be traced from about F to a little beyond H; in this continuous spectrum were distinctly present G, h, H, K, and several other of the Fraunhofer dark lines, showing that the principal part of the light of the comet was due to reflected solar light. There were also two groups of bright lines corresponding to similar groups seen in the spectra of carbon compounds. Some attempts have been made in the past year to apply photography to the spectra of some nebulæ, but hitherto without success. At Mr. Common's observatory photographs of Comet *b* were obtained on several nights. Encke's was found on August 27, and the satellites of Mars, *Phobos* and *Deimos*, were observed on the 27th of December, and their position measured. At Birr Castle Observatory, Parsonstown, determinations of the radiant heat of the moon have been made on several nights.

Only one minor planet has been discovered during the year 1881: this was discovered by Herr Palisa, at the Observatory of Vienna, on May the 19th. From an interesting research by Herr Hornstein, it appears probable that all the largest of the minor planets have now been discovered, and of those having a diameter exceeding twenty-five geographical miles the number is extremely small. It seems that the number of asteroids which have been already discovered, having a diameter less than five miles, is also very small, especially in that portion of the minor planet zone nearest to Mars. In the outer zone nearest to Jupiter, there may be a more considerable number of these minute bodies, probably too faint to be observed by the telescopes ordinarily employed in the search for minor planets. Omitting the few of comparatively large magnitude, the general average diameter of the remaining members of the group appears to be between five and fifteen miles—a much smaller diameter than has hitherto been assumed. Seven comets have been observed during the year 1881, one of which was the periodical comet of Encke. The first was discovered by Mr. Lewis Swift, on April the 30th; the second by Mr. Tebbutt, on May 22; this was the first of the two large comets which were everywhere observed in the northern hemisphere. The third by Schaberle (known as Comet *c*) was discovered on the night of July the 19th at the observatory of Ann Arbor, U. S. A. The fourth was Encke's comet. The fifth, a small comet discovered by Mr. Barnard, at Nashville, Tennessee. The sixth an interesting periodical comet discovered on the morning of October the 4th, by Mr. Denning; it is found to move in an elliptic orbit, with a period of 3,070·7 days; the orbit of this comet passes near to the orbits of Venus, the Earth, and Mercury; and it will therefore, probably be affected by considerable perturbations. The seventh comet was discovered on November the 16th by Mr. Lewis Swift.

The report also contains paragraphs referring to the Cape *Catalogue* for 1880, Prof. Newcomb's "Standard Stars," The Smithsonian "Report on Astronomical Observatories," "Physical Observations of Jupiter," Prof. Hall's "Observations of Double Stars," "Universal Time and the Selection of a Prime Meridian," and the volume of "Observations of the Total Eclipse of 1878, July 29," published by the United States Naval Observatory.

The President then proceeded to deliver his address on presenting the gold medal of the Society to Mr. David Gill, for his heliometer observations of Mars at Ascension, and the discussion of his results.

PROF. W. HOLTZ, inventor of the well-known Holtz electrical machine, has recently studied the various possible ways of arranging the inductors and armatures of his machine. This research was undertaken with a view partly to investigate the action of the analogous machine of Töpler, in which the fixed plate is not pierced, as in the Holtz machine, and partly to ascertain the reasons for the shifting brushes of light to be observed in the ordinary Holtz machine. The research, which is too lengthy to reproduce here, led to the conclusion that there is an advantage in the apertures of the fixed plate.

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